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THE WORLD IS ITS FIELD

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THE HIGHER LAW IN THE INDUSTRIAL WORLD.

"And we must take the current as it serves or lose our ventures."
—SHAKESPEARE.

By H. F. J. Porter.

Mr. Porter restates very effectively the proposition which is making headway too slowly among manufacturers and other employers—that it actually pays, in money and time, to treat employees with a high degree of consideration and sympathy, as well as with careful justice and fair dealing. The statement in this instance is forceful not only by the manner in which it is put, but because it is supported by recent, practical, and successful trial, and indeed is the record of actual results under working conditions.—THE EDITORS.

WHEN one man wants another who is considered an expert in his specialty to work for him at his most reasonable rate of pay, it might be supposed that the most natural way to go about it would be to lay before him in as glowing terms as possible the advantages to be obtained by accepting his proposition over any others that may be made to him. He should depict the attractive surroundings, the cheerful conditions, the pleasant associations connected with the situation, and the abundant facilities for doing good work which would be accorded his acceptance.

Then, after the expert had come to work, it would seem to be natural to arrange that everything which was held out to him as an inducement should be provided, in order that he should be satisfied and contented with his place. It would seem as if it might be a good idea to keep in touch with him regarding his needs and to furnish him with whatever was deemed necessary to perfect his work. It would also seem natural, especially if the work required a considerable length of time to finish, so that the expert's services would be desired permanently, to enter into some close relations with him, not

only of a financial but also of a friendly nature, so that his interest would be continuously enlisted in his work and he would not become dissatisfied with his prospects.

If, then, the conditions and relations above described are natural, or in other words, those which human nature expects and demands in order to secure hearty co-operation, why is it that when a man wants more than one expert to work for him continuously, as is the case in the many thousand industrial enterprises throughout the world, he does not naturally extend to these employees collectively the same treatment as he would to the single expert? In this connection it should be realized that in the specialization process which competition has brought about in recent years, employees, no matter how small and apparently insignificant their special operation, are to be considered in the light of experts. Why does the manager then, as a rule, herd these expert employees in dark, ill-ventilated work shops, provide them with poor facilities for doing their work, and offer them few or no comforts? With not only an absence of personal touch, encouragement, and effort to inspire interest in their work, but with the introduction of conditions which induce discouragement, fear of loss of position, and anxiety of mind lest bad workmanship of others may be charged to them and their wages cut proportionally without recourse to some arbiter of justice, will human nature on the part of the employee respond with cordiality to the full expectations of the employer? Certainly not. There is much simplicity in the attitude of mind of one who expects enthusiastic interest in his affairs to be displayed by his workmen when he openly shows that he takes no interest in them. Why are managers so short-sighted as to allow conditions to exist whereby they cannot expect to secure the best efforts on the part of their employees? One reason may be found in the inability to break away from tradition. Only as far back as twenty-five or thirty years ago, the owner and manager of an enterprise was himself better informed, of wider experience, and possessed higher mechanical skill than any of his workmen. He knew little or nothing of shop organization, but he and his men worked together with most intimate and cordial relations. He called his men by their first names and was their friend and adviser.

The manager of the present day, however, owing to the changed conditions of the times, himself seldom possesses any mechanical ability; and yet, owing to the traditions surrounding his title, he feels that he must pose as if he knew every detail of the business. In the larger enterprises of the day, where many hundred men

are employed, even the superintendent is selected, not because he is an expert mechanic, but on account of his knowledge of shop organization and management; and sometimes his foremen fall into the same category. The shop organization is framed on the military plan, with the employee in the ranks as the only expert in execution of the work actually in hand. In a military organization there is no touch between the commander-in-chief and his men. They are not allowed to think, but are expected merely to carry out what he has planned.

In the change from the old to the present system of management, the close touch between manager and operative has been lost, and with it much of the spontaneous helpfulness which accompanied the older methods. When, however, methods, are not natural, when numbers of men are governed by a system which does not bring from them the response which they ought to give freely, then it must be recognized that something is at fault, and either that which is missing must be supplied or a new system substituted. To show that this is not mere theorizing, it is only necessary to refer to the concerns that stand at the head of their respective industries, such as Fried. Krupp in Germany in steel; Cadbury's chocolate manufactory, and Lever Bros., Ltd. soap works, both in England; Marshall Field and John Wanamaker, the National Cash Register Co., in the United States, and many others, every one of which has realized the importance of appealing to the human element in its organization and by proper recognition and treatment turned it to account.

The methods adopted to bring about this betterment of industrial conditions vary considerably according to the circumstances affecting each individual enterprise, but the foundation in every case must be purely ethical, and the basic principles of right action must be strongly instilled into all its members in order to accomplish the desired result.

From my own experience of many years as a student of methods of industrial management, sometimes as an interested participant and at others as principal in introducing systems of organization, I have thoroughly convinced myself that all companies will pay their projectors better if they recognize the importance of securing the benefits that will accrue from utilizing and improving the intelligence which the employees possess. Some companies which have not paid may be so improved as to be considered successful enterprises by the accession of the brains of the working elements. An instance of this kind is fresh in my mind. The concern, operated under the ordinary system of management, had made two ineffectual efforts to market its product. By securing the enthusiastic co-operation of the working forces

the latter were soon doubled in number, the company was put on a paying basis in a very few months, and at the end of the first fiscal year realized a fair interest on capital invested.

Because of the resulting satisfaction to all interested, not only in this, but in every similar case which has to come to my attention, I feel that it is my duty to add to the testimony of those who have closely studied the working of the law of cause and effect as applied to the industrial situation—that not only do companies succeed which have adopted ethical methods of management, but they succeed *because* they have adopted them. This fact should be of interest to managers generally who are struggling with what seems to be a great problem in the industrial field, viz., the establishment of such relations between employees and employed as will effect the best results commercially and at the same time benefit all concerned. I presume that to those who are so interested, the ways and means of introducing these methods will appeal, because as far as I am aware, no such account has been recorded. In this article I am therefore responding to the many requests which have been made during the past few months to describe the principles which have been applied in the reorganization of companies, and the methods of applying them, so that they may be considered by the managing class in general and so much as is available in any case can, if desired, be adopted.

In the first place, however, it must be plainly stated that there is an educational phase to the situation. Although the principles underlying ethical methods of management are perfectly logical, still managers find it so much easier to follow custom than to comply with the exactions of logic that they actually hesitate to follow the dictates of their reason. For instance, before anything can be accomplished by a concern which evinces a desire to advance along modern lines, the following ideas must be strongly indoctrinated throughout the entire organization:—It must be recognized initially that if one man autocratically domineers the organization, its scope of expansion can never be any greater than what could be devised by himself. Also, that the character of work that may be realized from the organization as a whole will be no better than can be produced by the individuals that compose it. That if honest workmanship is desired honest workers will be necessary for its accomplishment; if rapidity in production of output is expected, skill and enthusiastic devotion to duty will have to be possessed by the operatives; if improvement is to be hoped for in methods and processes and perfection of product expected, the workers must possess intelligence and suitable opportunities for its

expression; if the organization as a whole is expected not to stand still, but to grow not only in size but in strength and character, facilities must be offered for the improvement of the individuals and inducements made for taking advantage of them; if untiring aggressiveness against competition is desired, absolute confidence in the enterprise and its product will have to be infused throughout the organization; and if harmonious co-operation between departments and management is to be effected, a spirit of mutual helpfulness must be imbued in the individuals comprising them respectively.

To accomplish all of this there is necessary only a change of attitude from one of force on the part of the management and resistance on the part of the workers, to one of "getting together" for a common purpose. In the atmosphere thus created the idler and the antagonist find themselves uncomfortable and either "get in line or get out." In other words, the situation presents a simple problem of cause and effect, the solution of which lies in establishing certain definite conditions, the results of which can be closely pre-determined. Methods which repeatedly verify themselves are scientific, and in this respect ethical methods as here applied deserve that appellation.

Presuming that the management is in a receptive frame of mind and sincere in its desire to adopt such principles as have been outlined above, it is ready to proceed with their application according to well defined lines; but it will depend upon the relations already existing between management and employee as to how long it will take to establish confidence in the attitude which the management is taking, which confidence is essential to the succesful development of the new methods.

In order to have a concrete case before us, I will refer to that above mentioned, which is typical of what may be found anywhere about the country, viz., a factory engaged in manufacturing electrical supplies in the center of a large city. One hundred and fifty employees equally divided as to sex. The ordinary type of management—employees hired, given a check number, worked all day, went no one cared where after leaving the shop at night.

The first thing done was the development of a chart showing the relations of the officers and departments to each other. Relations between members of the organization are undefined without a chart, but as soon as one is made, each individual in the organization knows exactly where he stands and what his specific duties are. Blue-print copies of this chart were posted on bulletin boards which had been distributed throughout the factory, at least one in each department.

Shortly afterwards, a factory meeting was called at noon time and all employees from the highest to the lowest were requested to attend. At this meeting, the writer stated that the company desired to change its method of management to one in which all the employees would have a voice. A simple explanation was given of the principles which were to govern. It was made plain that the success of the company must necessarily be dependent upon the reputation of the product in the minds of the public, and that that reputation could be made and sustained only by putting the best material and workmanship into that product. The company would guarantee to furnish the best material obtainable, but there was needed the help of the working organization to see that the best workmanship would be supplied. The company intended to pay the best wages, and it would adopt such a wage system that those who chose could add to their earnings up to the full extent of their ability. Opportunity would be given the employees to suggest any improvements, either in conditions affecting their comfort, in methods and processes of manufacture, or in design of product; and every suggestion leading to increased efficiency on the part of the employee or to the benefit of the company, would be accepted and generously paid for. An opportunity would also be given any employee to advance in the organization as rapidly as his capability would allow, and encouragement would be offered and facilities presented to advance from the factory into the office and selling organization.

The organization was requested to elect a permanent "factory committee" composed of representatives from the clerical force in the office, from the operatives in the factory, and from the foremen. After election lots would be drawn regulating the terms of service of those on the first committee, so that one member would drop out each month and a new member to serve for six months would be elected. In this way by a monthly change of one member only the personnel of the committee would never be seriously affected. The company would be represented in the committee by the superintendent of the factory who would remain as its permanent chairman.

There are always matters arising in every shop which employees desire to bring to the attention of the management. Sometimes through the scarcity of leaders in whom they might have confidence these matters go by default. At other times committees are formed hurriedly and therefore such matters are not intelligently presented. Here, however, was as representative a committee as could be obtained ready at all times to consider such matters and to pass upon them

intelligently for recommendation to the management, and a channel of intercommunication between management and employee continuously existed. The employees were requested to take a few days to consider the situation, which was of course entirely new to them, before proceeding to elect their representatives on the committee, in order that their selection should be of a type that would be both capable and responsible.

As soon as the committee was formed, the "suggestion system" was installed. The equipment for this consisted of small locked boxes distributed throughout the factory and the offices. The boxes were simple affairs with a slit in the top through which communications containing suggestions could be dropped. Each suggestion had to be signed by the author and enclosed in a sealed envelope addressed to the committee, otherwise it would not be considered. The committee considered the suggestions in turn, referring them to whichever department they affected provided they could not pass upon them unassisted. The action of the committee on each suggestion was embodied in the minutes of the meeting, which were typewritten in multiple and posted on the official bulletin boards in the factory and forwarded to the district sales offices. There were two sources of suggestions, viz., (1) the factory, (2) the salesman, and the suggestions, although classified, were not necessarily limited to the classification.

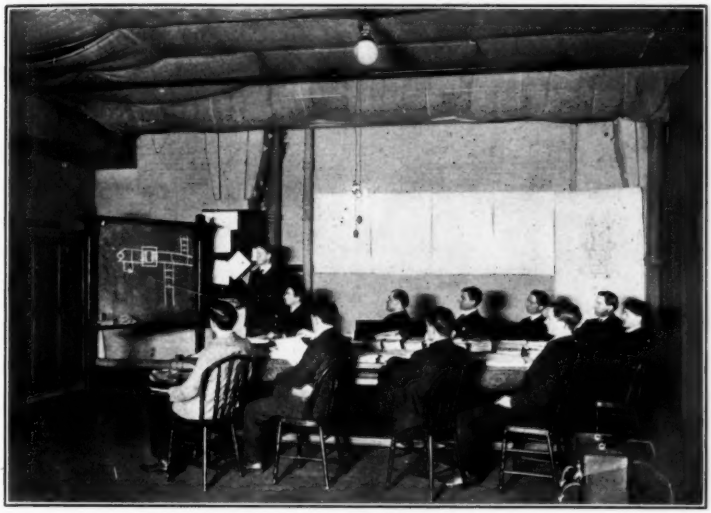
A schedule of awards for all suggestions which were recommended by the committee to the management for adoption was arranged in advance, and rules promulgated so that foremen would encourage their employees to think for themselves and suggest ideas which they felt would lead to improvement in the various directions scheduled. To prevent foremen suppressing suggestions, awards were made to those from whose departments the greatest number of suggestions originated, and if there seemed to be a lagging of the supply from a department at any time, its foreman was promptly called to account and urged to stimulate his employees to further initiative. Sometimes a suggestion would be made, which although totally unavailable would contain a latent idea which someone else would seize and utilize in other suggestions which would be practicable. In a very short time employees who were experts in their work, which perhaps consisted in repeating a simple operation many hundreds of times daily, sent in suggestions which sometimes saved considerable expensive material, or even eliminated the operation altogether. In cases of the latter class, besides paying exceptionally well for the suggestion, the operatives were put at other work and encouraged to develop their

capacity for initiative further. They were considered the kind of people it was desirable to keep. Salesmen soon forwarded suggestions, made primarily perhaps by some customer and modified and made practical by themselves. In a very few weeks the experimental department was crowded with work making the ideas thus received effective. The cost of manufacture was considerably reduced, and not only was the standard product perfected so as to meet the demands of the public, but new lines were successfully launched.

Here was shown the working of the law of cause and effect. The company had long possessed the intelligence of many minds which had never been allowed to develop and express itself. As soon as the opportunity was offered, and each operative found that it would be not only perfectly safe to offer a suggestion which would even at first glance deprive him or her of a livelihood, but that such a suggestion would lead to instant remuneration and to more profitable occupation, there soon blossomed in an apparently barren field a rich crop of ideas. Of course there was some chaff in it, but the machinery existed in the factory committee to separate it, and the conversion of the crop into money was accomplished only as rapidly as the company chose to spend the money for the purpose.

The spur thus given to the ambition of the individual soon gave evidence of the awakening of a desire to improve in knowledge in order to advance. Many employees entered correspondence and night schools. A clerk in the correspondence department started an evening class of stenography and typewriting at a nominal sum per head, but which netted her a neat little sum per week. Another in the financial department likewise offered his services as teacher of a class in book keeping in the evenings, and there was a general uplift to the whole situation. Several social and other organizations were formed among the employees—notably a Musical and Dramatic Association, a Literary Club, a Camera and Sketch Club, an Athletic Club, and a Mutual Aid Association.

Preference was always given, other things being equal, to an employee whenever a vacancy developed in any department. It was understood, however, that no one would be promoted from the factory unless an understudy was ready to fill the vacancy thus occurring. In this way ideal conditions were established for improvement and for helpfulness which most excellently served their purpose. The recruiting of a sales organization offered a special opportunity to inspire the ambition of the individual in the factory organization to advance. A school was established for thoroughly equipping prospective salesmen



SALESMEN'S SCHOOL AT THE FACTORY, IN SESSION.

for their duties, the instructor being a college graduate with the degree of Electrical Engineer who had advanced to the sales department from the experimental section of the factory. Arrangement was also made so that the students could take a course of instruction by correspondence in some of the schools of salesmanship which are doing excellent work about the country. The knowledge of the product, possessed by salesmen who had developed from the factory, established a confidence in it which no amount of hearsay evidence could have produced. No matter what objection was raised against it by prospective purchasers, the salesmen were never at a loss for knowledge to refute it if untrue, or to overcome it if true.

The fact that the sales offices of the company, scattered about the country, were supplied with people who were once in the factory, developed ties of mutual helpfulness toward a common aim. The interdependence of the two departments was brought home to each at every return of the traveling element to the factory; and on the semi-annual meetings of the district sales managers at the factory the home organization extended a royal welcome through their social organizations, in the winter by a musical and dramatic entertainment and a dance, and in the summer by a picnic, with athletic sports. It was on these occasions that the semi-annual distribution of awards for suggestions was made.

THE EMPLOYEES' ANNUAL MIDSUMMER PICNIC.

It was interesting as well as gratifying to see how willing outsiders were to help these people to help themselves. Some employee suggested that it would be a good thing to have some lectures in the factory building from time to time in the evening during the winter months. A sub-committee was appointed by the factory committee and a course of lectures by some of the most representative people in the city was the result. A nominal fee was charged for attendance at these lectures. This fee was devoted to the support of the band, which was part of the "Musical and Dramatic Association" and was always a prominent feature, both before the lecture in rendering several pieces of high-class music and afterwards to accompany a reception and dance lasting for about an hour, during which the employees enjoyed meeting the speaker of the evening and other guests who might be present. The piano belonging to the band was kept in the girls' dining room and was enjoyed by them every day at luncheon.

Tickets were sent by several outside societies in the city admitting to their lectures, musicales, art exhibits, etc., as many as could attend. Another sub-committee which was requested to procure reading matter

for the employees was promptly advised by the local Carnegie Library that a branch of that institution would gladly be installed in the factory building.

The health of his employees should be of primal importance in the thought of the manager. No one can work at his best when he is not well. No work can be good when performed by some one who is ailing. There is besides a depressing effect upon others caused by the presence of one who is not in health and naturally complaining. Much of the ill health of the general run of people comes from eating food which is not wholesome, from eating too fast and from lack of exercise. Most of the indisposition of the employees was traceable to indigestion, which they were accustomed to alleviate by recourse to patented nostrums. Advice given by the physician and the matron regarding diet not only improved the physical as well as the mental condition of the force, but raised the average attendance at the factory very considerably. The Mutual Aid Association proposed primarily to provide the attendance of a physician in case of sickness and the payment of a stated sum of money during that time. Its best work, however, was directed towards preventing illness through a course of lectures by the physician given to the employees on "How to Keep Well," and through his collaboration with the matron, who ministered to their temporary ailments.

THE GIRLS' LUNCH ROOM.

GIRLS' REST ROOM.

The lack of exercise showed its effect on the operatives especially during the winter time just after noon hour when they would resume their work. It was very noticeable that for some time it would be difficult for many of them to stay awake, and this hour was not a profitable one for the company. When the men of the organization appreciated how little exercise they obtained owing to the sedentary nature of their occupation, they joined the Athletic Club, which then petitioned the management for space (of which there was plenty in the factory building) in which to instal some gymnastic apparatus for use at noon and in the evenings. The money to purchase this they themselves arranged to provide.

Worry over family and other troubles is another source of ill health. Information promptly reached the management through the matron when family conditions were distressing an employee, which a helping hand at the right moment could relieve. Close ties were thus formed which linked the employee and employer together and served to develop the spirit of loyalty which is an invaluable possession.

Some managers say that they are not interested in knowing what their employees do outside of working hours. Some employees say it is none of the manager's business to know what they do in their own time. "When," however, as old Gorgon Graham says, "what the employees do in their time affects what they do in the employer's time" then it may be to his interest to make it his business to look into such matters. When this is done with a spirit of helpfulness the employee welcomes it, barring him who wastes his time and money in a way to render himself unfit mentally and physically for good work; and for his opinion regarding the employer's methods the latter does

not cherish a very high regard. It should be remembered, however, that in every factory organization there are apt to be many operatives who, because they are strangers in the locality or from reasons consequent to their condition and circumstances, have no opportunities for social recreation and pleasures and no places to go after working hours, and therefore, being more or less the creatures of circumstances, drift into associations and habits which may be debasing in their tendency. This sort of thing leads either to a lowering of the status of the organization, if they remain in it, or to an unsettled state, if there are many changes due to constant removals. The social instinct in man causes him to seek companionship, and if opportunity is given the members of the organization to attend lectures and other meetings which are attractive and at the same time elevating in their tendency, the whole fabric of the organization becomes homogeneous and remains intact.

The character of the individual should be a no less important consideration in the mind of the employer than his health. It is very necessary to know whether or not the employee can be relied upon in the quality of his workmanship and in his effect upon others in the organization. In fact, health, character, and education are the factors in the make-up of the employee which must receive the serious consideration of the employer, and their relative importance is shown by the order in which they are named.

It has already been said that in order to secure the best quality of work the mind of the worker must be as free as possible from distracting thoughts. Peace of mind cannot be maintained while conditions exist which entail loss of employment, reduction of wages, nagging by foremen influenced by favoritism, unpleasant or unhealthful surroundings, ineffective facilities for service, etc. Not least

DINNER TO DISTRICT SALES MANAGERS, AT THE OFFICERS' CLUB.

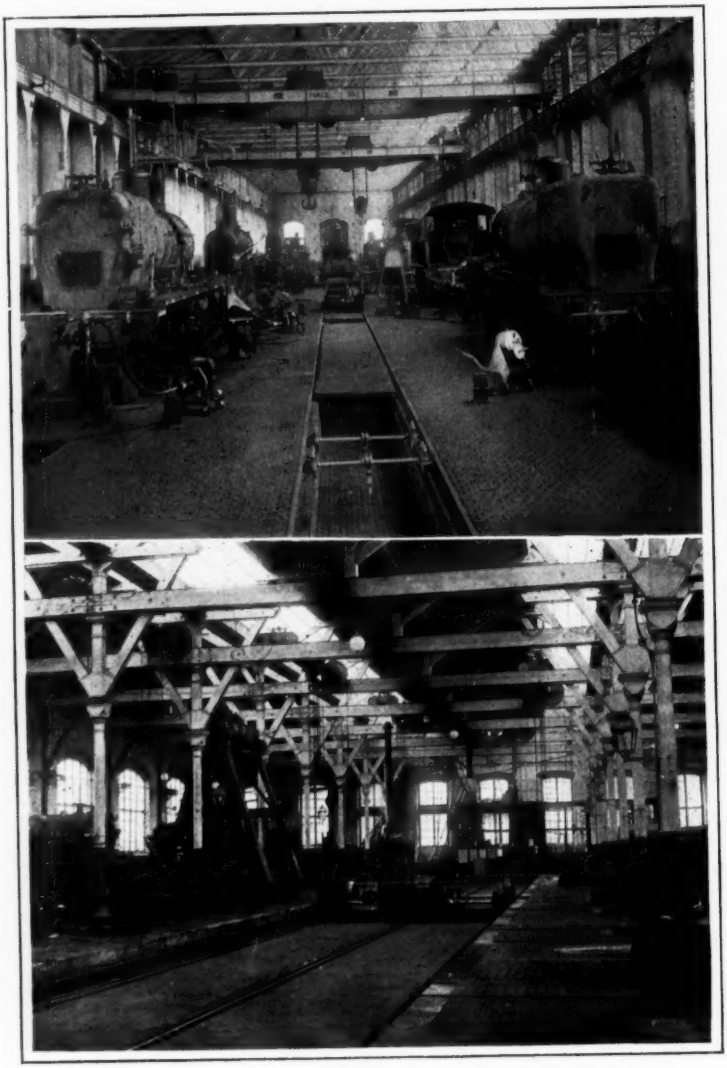
GROUP OF EMPLOYEES WHO PARTICIPATED IN THE MIDWINTER MUSICAL AND DRAMATIC ENTERTAINMENT.

among thoughts which are disturbing in their nature are those which include fear of danger from accident. Laws have been enacted making certain safeguards obligatory. Besides the ordinary precautions demanded by law, however, there are moral obligations which are equally mandatory. Statistics show that in case of fire more fatalities result from panic due to fright than from the fire itself. To the manager who is mindful of the interests of his company, his employees, and the community, it therefore becomes necessary not only to comply with the law compelling the provision of fire escapes, water buckets, standpipes, hose, fire extinguishers, etc., but to assign to certain people the duty of keeping this apparatus in serviceable condition and to drill them in its use. The practical efficiency of a complete fire drill has been so repeatedly demonstrated that public opinion, through its medium, the press, is now demanding that laws be enacted compelling factories to adopt it. The housing of many human beings in a factory building should entail the responsibility of their protection and ensure their safety in case of fire. In the factory in hand the fire drill was inaugurated, and the very first exercise developed the absolute impracticability of the type of fire escape provided. The first whistle, through

mental association with sudden danger, at first caused some of the girl employees to faint from fright. This feeling was soon overcome, however, and complete drills were enacted without any excitement whatever. Occasional repetition of the drill reduced the time of exit from the building from more than seven to less than three minutes, a saving in time which would in case of fire be the cause of preserving many lives.

It must be evident to the veriest tyro in management that unless the employees are made to realize that the company feels an interest in their welfare, they cannot be expected to display a kindred feeling towards the company. The methods here introduced, however, furnished an incentive on the part of the employees to give to the employer the best there was in them, and not only during working hours but at all times, the forces of personal interest, enthusiasm, and individual capacity were directed towards the welfare of the company.

Pressure was at times brought to bear on the company to advertise what it was doing in the nature of industrial betterment. This was always resisted on the principle that one should not advertise the fact that he is doing simply what is right. The employees spoke to their friends of how they were treated, and the list of applications for positions by the very best class of employees from other factories, not only in the neighborhood but at a distance, was a long one. Employees are not slow to learn where they will receive the greatest benefit and they promptly seek that place. As the system became established, the undesirable element among the employees retired in the face of the pressure from outside of others more worthy, and through this change the whole organization awoke from a sullen stupor into a sentient being full of life and feeling. It was the intelligence and vital force of this organism that put the company on a paying basis, testifying to the efficiency in the industrial world of the ethical laws that "right makes might."



THE ERECTING SHOPS OF THE "EST" RAILWAY AT EPERNAY, FRANCE.

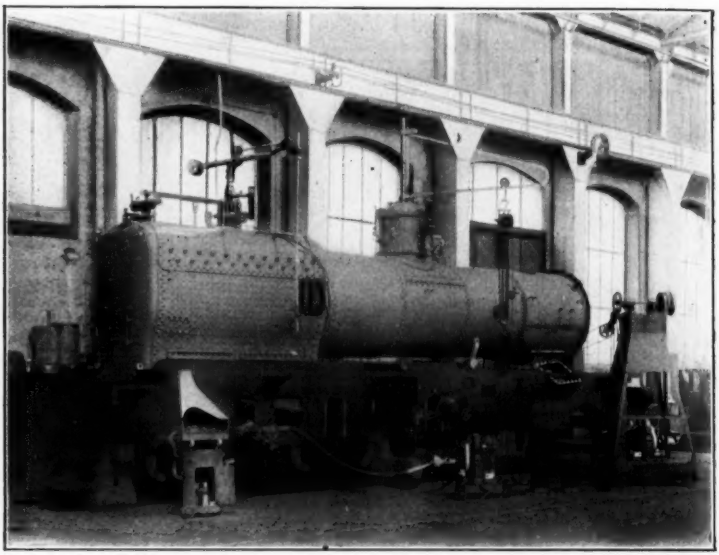
A LARGE LOCOMOTIVE BUILDING AND REPAIR WORKS IN FRANCE.

By Charles R. King.

Mr. King's first article, which appeared in our issue for July, treated of the general arrangement and equipment of the Epernay shops. The present part, concluding his description of these noted Continental works, deals chiefly with their mechanical practice and management methods and policy.—THE EDITORS.

THE erection of an engine at Epernay is generally effected over the side tracks upon the heavy wooden trestles which are noticeable in some of the views. Before the engine leaves the shop to be fired up outside for the hot tests, the weights under each of the tires are ascertained by means of an Erhardt weigher located at one extremity of the building. The shoe of this apparatus rests on the lower flange of the rail and by working the lever the wheel tire is raised one or two millimeters off the rail-head. For the regulation of the slide-valves, after the erection of the valve gear and before the side rods have been fitted to the wheels, it is necessary to be able to turn the wheels without moving the engine from its place. This is done by the aid of a very simple arrangement consisting of a spindle carried in special bearings resting one on each of the rail stringers and the spindles projecting through the bearings close up to the rail. Parallel with the spindle and carried by the same support is a stump spindle or loose roller, and it suffices to raise the wheel slightly in order that the flange of the wheel may drop in between these two spindles. A ratchet provided at the middle of the shaft is operated by a workman in the track pit, and thus the wheels are turned round slowly for making the necessary valve adjustments. A couple of these appliances may be remarked in the foreground of the upper view on the opposite page.

One of the numerous handy devices (of which so many are to be seen in use at Epernay for registering with precision the movement of any working part of a locomotive or for laying out erection work) consists of an attachment for the valve-chest ends by which the adjustment of the valves can be arranged with the greatest of facility, even with old types of engines wherein formerly, as in England at present, the slide valves were placed vertically between two



A LOCOMOTIVE UNDER ERECTION AT THE EPERNAY SHOPS.

Showing a small portable jib stepped into the steam-dome cover, with differential blocks for lifting heavy parts of the motion, etc.

inside cylinders. It comprises a bracket fixed to the front of the valve chest, close up against the "tail end" or extension of the valve spindle, and upon it are two adjustable cursors, the outer edges of which are set to represent the outer edges of the two steam ports. Upon the end of the valve-spindle extension itself another plate is fixed, and upon it are two regulatable plates or cursors whose outside edges are set to represent the extremities of the slide-valve; and when the wheels are turned by the ratchet apparatus just mentioned, the relative positions assumed by the valve on its valve-seating are exactly recorded outside. The steam port and the exhaust port dimensions are not visible from the apparatus, but for the verification of the valve setting this is not necessary. These instruments serve for several different types of locomotives.

For the lifting up of heavy pieces belonging to the motion or to the carriage of the engine, differential pulleys are used, suspended from a jib, the bearing for which is stepped into a hole in the steam-dome cover of the particular locomotive undergoing repairs or erection. This idea is shown best in the view just above.

The parallelism and the geometrical squareness of all the members which form locomotive frames are tested by several different systems of gauges. It has been said that a locomotive-engine frame ought to be machined so exactly that it would tumble together without rectifications as easily as does a machine-made door. This is approximately possible where, despite certain objections, the frame plates have been planed inside and where long cast-steel frames or stretchers are used for bracing the plates. On the Continent, planing the inside of a plate frame is not approved of, it being considered that the skin of the plate is thus unequally cut through and so is liable to cause subsequent buckling. At Epernay, as well as in most European shops, recourse is always had to very exact tests for the rectitude of all the parts built into a locomotive frame. When the frame has been squared with tight-wire lines, the cylinders are temporarily bolted in place and the same means is used to verify their alignment, with respect to the driving-axle centers, and to the axial line of the cylinders, as also in relation to all the horn blocks or pedestals. Commencing with the alignment of these blocks, the Epernay shops employ a large gauging square which is bolted to the frames, between the horn blocks, by means of brackets and two of the horn-block bolts. Upon the cylindrical body forming the base of this instrument, and midway between the frames, is a long arm or compass beam with a needle point which must, in turning, fall exactly on the tight-line representing the cylinder's axis—first at its forward end and then, when turned around on the pivot, at its backward end. Further, upon the same brackets bolted to the engine frame, is fixed a heavy beveled-edge steel rule of which the feather-edge will represent the theoretical center for the axle when the horn-blocks have been duly verified as to being square, horizontally, with the axis of the cylinders, and also perpendicular to a line passing through the same axis in a vertical plane—all of which positions can by this instrument be ascertained with rigorous exactitude. The parallelism of the crosshead guides in respect to each other and in respect to the longitudinal axis of the pistons is tested by means of a gauge fitting in the inside of the guides and having a rack-and-pinion movement at its midlength, adjustable laterally against the side of the piston. This appliance is of the simplest kind but it permits the gauging to be done rapidly and with all-sufficient accuracy.

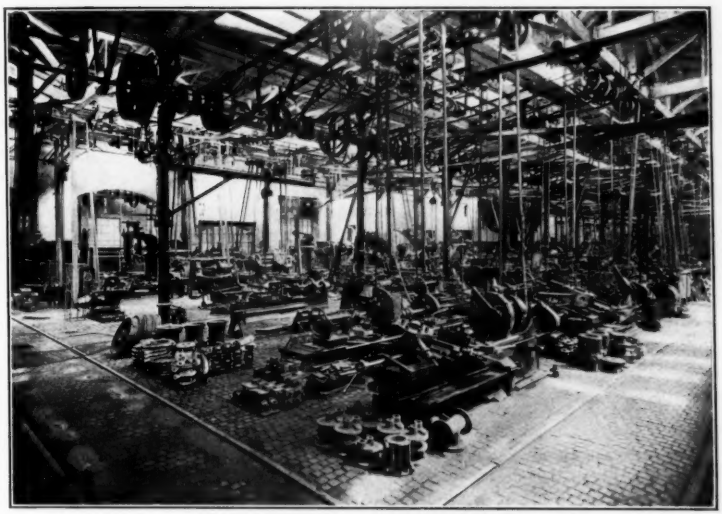
For adjusting all the horn guides in a same plane parallel to the cylinder's vertical axis, a tight line, run through the middle of the cylinder, again serves as the basis for the measurements, and a square,

provided with a fine-pitched worm screw and cursor, is successively set up against the inside edge of each of the horn-blocks; the fine adjustments thus made being absolutely exact. All the horn-blocks, of course, previous to these measurements, will have been set exactly plumb by means of a plumb square. Work of this kind is necessarily expensive, but it is more than repaid in the production of engines that run with a minimum of internal fatigue and continue to run when a cheaply-built engine would have already disappeared from service.

Plate-Frame Construction.—In the frame department there are the usual large triple-head boring machines and a very fine double-head frame-slotting machine by the Sächsische Maschinenfabrik of Chemnitz—which is the standard tool employed for this work in nearly all Continental locomotive shops.

The riveting of the frames is generally done by hand and with cold rivets, it being considered that a cold-driven rivet fills the middle-length of the rivet-hole much more thoroughly and with a greater density of the middle fibers than a hot rivet, with which the exterior portions of the rivet hole are more readily closed up, before the inside stem has had time to be equally compressed throughout its length. Cold riveting is considered to be the best work where there are several thicknesses of plates to rivet up and where shearing efforts have to be resisted. For the frame caissons or "stretchers," however, the rivets are closed by machines. At that part of the frame to which the horn-blocks are attached it is usual at Epernay to rivet a heavy reinforcement plate of horse-shoe form over the outside surface of the frame. The horn guides at these works are usually cast in two pieces instead of one piece as is now more usual elsewhere.

General Machine Shops.—The machine shops have an excellent tool equipment with machines from nearly all tool makers on the Continent of Europe and also from England and America, although, of the two latter, the former predominate, especially in the automatic department where for bolt and screw making the sets are mostly from Herbert of Coventry, and also from Pratt & Whitney of Hartford. Among the newest automatic machines is a Herbert lathe for copper screwed stays and another for screws and bolts; a lathe for crown-stay bolts by Jones & Lamson; a milling machine for working long surfaces by Loewe & Reinecker, and the well-known radial-arm machine of Kendal & Gent for drilling and tapping cylinders. There is also a multiple-spindle drill for cylinder work, boring eight holes simultaneously on the system of Habersang & Zinzen of Dusseldorf.



FITTERS' MACHINE SHOP.
Showing installation of Gisholt lathes.

In the fitting shops there is a set of three Gisholt lathes which are to be seen in the foreground of the view above. These machines are employed principally for such repetition work as pistons, piston rings, stuffing boxes and packings, brake pumps, brake cylinders, and valve-chest liners, also for the piston-valves. Some of the work done by these machines may be observed in the same view. The European shops are few where these celebrated machines are not highly appreciated.

Capstan or turret lathes ("revolvers") are largely employed at the Est works for small parts, and these are shown in the background of the view on page 662 behind a row of milling machines. Milling machines are employed instead of planing machines wherever possible, and sometimes also for smaller parts where their use involves complicated forms of cutters, such as for milling reversing-gear handles, and the jigs for such pieces are frequently contrived so that the whole piece may be finished throughout without moving it on the milling machine. The I-section main rods and side rods are machined entirely from end to end by milling machines, and as much as possible at one pass. A cutter of large diameter is preferred, one having many more teeth than in the smaller sizes, and which, while holding out for use longer, yields smoother surfaces with a less loss of time un-

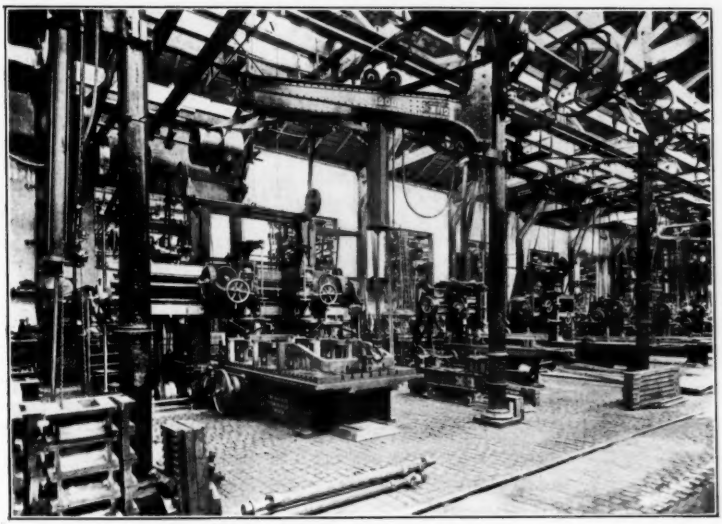
avoidable for sharpening. The solid cast-steel cutters have a diameter of 10 inches by a length of 16 inches and weigh 400 pounds. As occasional accidents in hardening are inevitable after repairs, the Est has for some years past employed cutters with changeable cast-steel teeth set in a core of mild steel. These teeth are helical stampings, and each blade is in two pieces with a splice at the joints. A cutter of 10-inches diameter and 12-inches long weighs 375 pounds.

GENERAL MACHINE SHOP. CAPSTAN-LATHES AND MILLING TOOLS.

These milling cutters can remove from a surface of medium-hard steel, when working at a circumferential speed of 40 feet with a feed of ⅝ inch per minute, a weight of 15½ pounds in 10 minutes, equal therefore to 93 pounds per hour, the cut being 15½ inches wide by ⅝ inch deep. Besides serving for the heavy motion rods they are employed for machining the insides of locomotives axle-boxes when these latter are set in gangs, as is practised also for machining the surfaces of cross-head guide bars. It should be observed that the side rods of Continental locomotives have very broad ends to be machined. A simple bushed eye, as in American and English engines, does not meet the need for taking up play.

For milling over every side of the foundation rings of fire-boxes a heavy English machine with double milling spindles is employed. This is an especially fine machine by Muir of Manchester, and its details may be noted in the view opposite, where it stands in the

foreground. It is served (as too are the adjacent machines) by pillar cranes of 1½-tons lifting capacity worked by compressed-air cylinders, to be noted in the same photograph. In this interesting part of the works may be seen a Langbein milling-machine for sawing off the rough edges of all pressed-steel or flanged work, or the lower edges of assembled fire-boxes. This machine is much used throughout the Continent for milling the edges of all boiler plates that have been bent at right angles, or for dressing the edges of an assembled boiler ring. Its milling cutters are practically fine saws, and the tool provides all hinged motions for following around automatically the contours, regular or irregular, of any pieces upon which it is set to work. The two rollers which support the opposite sides of the piece being worked have sufficient space between their inside edges to allow the passage between them of the milling cutter when it has cut right through the plate. For grinding out, after hardening, the grooves of the box-type valve-motion links so much in vogue on



MILLING-MACHINE DEPARTMENT.

Est locomotives, there is a very beautiful grinding machine designed and constructed at Epernay and kept in a room by itself. It consists of a strong vertical grinding head and a box table about 2 metres long. Its principal feature is the means by which the small traveling platform carrying the link can be made to describe an arc of longer

or shorter radius to suit different radii of links. For this purpose the grooved slide-bed is hinged at the middle and its ends are adjustable by screw to a very fine scale marked upon the extremity of the bed. Depending upon the obliquity given to the jointed bed, and the obtuse angle which is so formed, the carriage holding the link turns through a curve of proportionate radius.

Wheel Shops.—The whole shop is a fine modern building and one of its bays is shown on the opposite page. Here the materials are handled by an electric monorail 4-ton floor crane of the Dyckhoff system with a motor of 4.6 kilowatts for lifting and another of 3.2 kilowatts for traveling, both by the Société Alsacienne de Constructions Mécaniques. For local service there are several half-ton radial-arm wall cranes. In the view given the floor crane is about to lift some driving-wheel centers for mounting upon the various lathes. Until recently the wheel centers were forged and were supplied from such firms as the Compagnie des Forges et Aciéries de la Marine et d'Homécourt at St. Chamond; from Deflassieux Frères at Rive-de-Gier, and from the Société Anonyme des Etablissements Arbel, also at Rive-de-Gier; but now, with the excellent results given by steel castings (a wheel center never having been known to break in a service of seven years) steel-castings centers are used and are supplied from Schneider & Co., Le Creusot; from the Compagnie des Forges de Châtillon, of Commentry et Neuves-Maisons, and also from the St. Chamond company previously named.

The lathes used are principally of well-known European types; but there is also a new wheel lathe by the Pond Co. and a vertical lathe or mill by Bullard of Bridgeport for diameters of up to 5 feet 3 inches. It may be mentioned, incidentally, that throughout the Continent few locomotive builders ever employ these latter machines for large work, or to anything like the extent customary with stationary-engine builders.

The method of securing the tires to the wheel center is, as now usual on the Continent, by safety rings—these rings being bent up in a small hand worked machine by Henschel & Sohn of Cassel (Germany). There is an extensive outside annex for the wheel shop termed a "wheel park" where all the new wheels and axles mounted are laid out according to the types of locomotive for which they are intended.

Axles, straight and cranked, are also machined in the same wheel shop. The forgings for the crank axles are of course obtained outside, the firms supplying them being the "Fonderies, Forges et Acié-

ries de St. Etienne"; Schneider et Cie of Creusot; A. Lacombe et Fils of Rive-de-Gier and the Forges et Aciéries de la Marine et d'Homecourt at St. Chamond.

Out of all the "Est" four-cylinder compound locomotives there are 83 which have the modern-type oblique-shaft crank-axle ("bras-oblique") that is now so much used on the Continent of Europe from its being much stronger in its form than the old right-angle crank type, still employed in England, but rapidly becoming obsolete on the Continent. Taking the whole of the inside-cylinder engines of the Est, both old and new, 40 crank axles of all kinds are renewed each year, the fractures when they occur generally starting in the crank pins.

TURNING SHOP FOR WHEELS AND AXLES.

A crank axle for the 6-10 type four-cylinder compound weighs when completely finished 2,035 pounds, and costs for material and work about 14½ cents a pound. The form of crank cheek or web now preferred at Epernay is not of the circular but of the elliptical pattern, although the circular pattern has an advantage over this last for the more easy fitting of the reinforcement hoops. Such a one, but with a straight-arm axle, is shown on the right-hand lathe in the view above. Here there may be noticed an arrangement (rarely employed elsewhere) for supporting the middle of the axle while on the lathe. Attached to the middle of the axle is a collar

which is hung from a pulley on a roof beam by means of a broad strap, which latter passes over it to a second pulley and then down to the rear of the lathe, where there is a well in the floor for a heavy counterweight attached to a long rod in connection with the strap. Thus the axle has no weight on the lathe centers and consequently can be manœuvred with especial facility on the machine.

Boiler Shop.—This shop is served with an electric traverser mounted with a Gramme motor of 3.3 kilowatts (4.4 horse power). The furnaces, plate rolls, edge planers, drills, riveters, and other large heavy tools are only a repetition of all such plant usually seen in Continental works. The water used in the Est locomotive boilers is of a variable purity; on the whole it is calcareous. When taken in at Paris the water is notoriously hard, and at Epernay also it is calcareous and an old leak in a boiler under repair shows up this fact; but at Belfort, near the end of the Est lines, the water is remarkably soft. It is interesting therefore to know the nature of the repairs required by the steam generators. Out of one hundred boilers entering for repairs, seventy will be for renewals of the fire-box (always of copper), ten only for the tube plates, and twenty for various small boiler jobs. At present all the tubes are in mild steel, brass tubes having now been completely discarded just when elsewhere (i. e. in Italy) the steel tubes are to be entirely replaced by brass ones. The "Est" steel tubes have not the copper ends common in Continental practice—and even when they are repaired the piece soldered on is also of mild steel.

The copper stays for the fire-boxes are bored, at the inside ends only, with a hole 6 millimeters diameter to reach just as far as the water space. They are manufactured complete—viz., turned, screwed, and cut off to the required lengths—in a Herbert (Coventry) automatic machine, the quantity produced per hour averaging forty.

The stay-holes are tapped and screwed home by means of a 2.3-kilowatt Belfort motor already described. All the boiler riveting, caulking, and tube-beading is done by compressed-air tools—Boyer's being in general use. The air-compressing plant in the power house is also American—the compressor being by the Rand Drill Co. of New York—a two-cylinder compound machine with water circulation having a capacity of 7,000 litres per minute forcing the air into two reservoirs of 142 cubic feet capacity at a pressure of 94 pounds per square inch, and ceasing work when full pressure is attained.

The boilers and cylinders are not jacketed with any non-conductive material, but are merely covered with an airtight sheathing according to the general Continental practice.

The chimneys of the "Est" locomotives are usually made from wrought iron for the sake of lightness. Across the top of the blast pipe there is a strip of metal with an inverted cone riveted below it, its purpose being to spread the steam issuing from the pipe and to make the jet fill the chimney more completely—although it may be noted here some very much more elaborate arrangements, spreading the jet very effectively, have elsewhere been found to produce no appreciable advantage upon the draught.

Foundry.—The foundry, which is located at the end of the works nearest the railroad line and next to the forge-shops, employs one hundred men in the iron and brass departments. The iron foundry has two cupolas, one of 4,000-kilogrammes and the other of 1,800-kilogrammes capacity per hour, and casting is carried on daily.

The locomotive cylinders cast at Epernay appear to be of very good quality and the mixture employed is:—

English pig	30 per cent.
French hematite	30 " "
Old cylinder scrap	20 " "
Best chosen C. I. machine scrap	20 " "

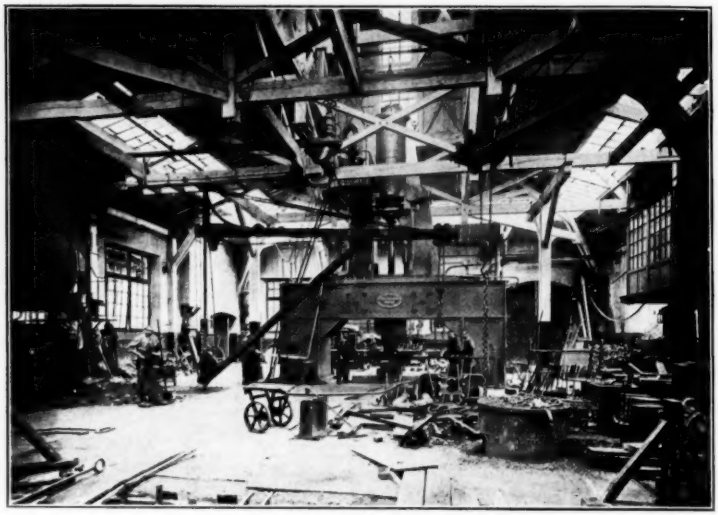
The following mixtures of sand, etc., are employed for moulds that have to be ovened:—

Green sand of Sainte Menchould	6
Mineral black (pulverised coal)	1
Old sand	8

A deep runner-head is usually employed for obtaining the required density of material in the cylinders.

The foundry "monkey" is located directly outside the cupolas so that there is practically no horizontal distance to traverse in carrying the prepared "scrap" to the furnaces.

Concentration, and Axle-Box Forging.—Between the foundry and the forges is a cementation department. Cementation and annealing are largely practiced. All the valve-gear parts are cemented, also the rod ends, brake parts, and forged axle boxes—though it may be remarked here that steel castings are now becoming very general at Epernay for axle boxes. When locomotive axle boxes are forged, their great depth causes difficulties in the employment of dies, so that at these shops the method usually followed is to first forge a straight piece having a swell in the middle for the crown of the box, then to swage the edges to the usual ⌐ section, and subsequently in a mould to draw down the middle or crown portion and complete the operation of forging the crown between dies. After this the long ends forming the sides of the box are bent down between two outside anvil blocks, and finally the piece is completed upon an internal model or saddle block.



A PART OF THE FORGE SHOP.

For the making of an axle box, weighing when fully machined 110 pounds, it suffices, with this process, to start with a block of 265 pounds. The rough forging weighs about 180 pounds.

Forge.—In the smithy the largest steam hammer (see view above) is by Thwaites Bros. of Bradford (Yorkshire), and was erected in 1902. It gives a blow of 12 tons. The steam cylinder has a diameter of 38 inches and has a maximum stroke of 7 feet. It is used principally for drawing ingots and forging locomotive rods and guide bars, as also for forging large work in dies. This forge shop is one of the busiest in a locomotive works that I have seen, and as it is very crowded with machines, accidents from sparks are alone prevented by the use of numerous iron screens set up on the floor between the various hammers.

The steam hammers are supplied with steam from two locomotive-type boilers mounted directly on the top of the forge furnaces. One of these boilers may be seen in the left hand of the view Figure 14. They have a heating surface of 176 square metres each (1,893 square feet) and are intended as a permanent installation. In the bolt-making section of the forge shops the machines are run by a Gramme motor of 9,350 watts.

Paint Shop.—The paint shop is a relatively important one for such a works as Epernay. It can accommodate twelve locomotives and

tenders, whereas in most French, Austrian, and Italian locomotive works six is the usual capacity while at certain model works near Berlin four locomotives without tenders is the accommodation afforded and at Stettin (Pomerania) one locomotive without tender is got into the painting shop with difficulty.

Continental makers would like to be able to finish their engines with the hard durable painted surfaces which serve to give steam locomotives in England such an attractive appearance. On the contrary, Continental paints absorb the machine-oil and deteriorate rapidly so that the labor of keeping locomotives clean is an onerous one and especially so in France, where endeavours to keep up the fine painted appearance of a new locomotive are soon abandoned. But when quite new the engine painting is fully as creditable in appearance as the best English work, while the machinery itself of the Continental engine is certainly not inferior either in proportions or finish to work done elsewhere.

For the service of this shop there is a 38-foot 6-inch turntable provided with a 3,300-watt electro-capstan for turning the table and for hauling cold locomotives. The same motor serves to pull engines into or out of the painting shop. The paint-preparing shop has mixing and grinding mills and a grind stone for sharpening tools, all run by a Gramme motor of 3,300 watts.

The oil-stores, etc., are contained in an isolated building where the motive power consists of two Gramme electromotors each of 1 kilowatt, one for a 1-ton elevator and the other for a rotary-oil-pump. For extracting the oil from turnings and borings there is centrifugal machine by Reed & Curtis.

Materials Testing.—In the materials-testing department there is a tensile testing machine for metals worked by a Postel-Vinay motor of 4.6 kilowatts (6 horse power). For testing by concussion the samples cut from piston rods and valve spindles are placed under a falling weight or "monkey." For the last seven years the "Est" company subjects these parts to a system of double hardening which has had a remarkable effect in increasing the strength. The steel employed has, before treatment, a tenacity of 50 kilogrammes per square millimetre and an elongation of 25 per cent. After forging the rod is heated up to 950° and then plunged vertically into water that is steam-heated up to 70°, and left therein until it is quite cold. The rod is then reheated to 500° and again treated in the same manner. A rod scarcely ever breaks that has been treated in the way described. The test specimens are 20 millimeters thick and after

being nicked with a triangular cut to a depth of 1 millimeter they are placed upon supports located 106 millimeters apart. The "monkey" has a weight of 50 kilogrammes (110 pounds) and is sufficient to break specimens cut from ordinary annealed pistons when falling from a height of 25 centimetres, while samples cut from the same piston, but double-annealed, do not break until the height of fall is increased to 2.30 metres and occasionally to as much as 3 metres.

General Installations.—The lighting, warming, ventilating, and hygienic installations in general of Epernay works are especially worthy of attention, if it is remembered that the conditions to be met were not entirely the same as with new shops—the laying out of which presents little difficulty with the specialised systems of heating and ventilating now available. For the lighting there are three Gramme six-polar dynamos driven by belting from the Corliss engine, their full-load efficiency being 86 per cent. and each delivering 36 horse power, or a total for the three dynamos, at a tention of 110 volts, of 108 horse power. Incandescent lamps are comparatively little used because of their fragility and small electrical output, but those already installed are kept up for night-watch service. The principal arc lamps are of Bardon type of 8 amperes. In the new erecting shop there are 44 such in the side aisles suspended at a height of 17 feet and 10 more in the middle passage at a height of 33 feet—which permits of the crane passing beneath them. The number of lighting hours is 400 per year. The switchboard permits of using the dynamos either for lighting or for power. The total production of electric power is 117,000 watts, representing 160 horse power. Of this 66,000 watts or 90 horse power is available for motive power, while the nominal strength of the machine motors in the shops is much more, being 174 horse power; but the power provided is largely sufficient since the normal capacity of the motors is much in excess of what they absorb on an average, and also because the small-tool motors are never all running simultaneously.

The central heating system consists of 1,200 metres of steam pipes connected with irradiator stoves. These were adopted because had floor-heating been employed the pipes would have to have been laid in floor-channels, and with the level attained by Marne floods this would have been impracticable. The channels also would have cost more for installations, and with the severity of the climate it was desirable that a workman should be able to warm himself up locally when the temperature had descended—as often happens in winter—

to — 15° C. and since it would not be possible to heat up the 80,000 cubic metres of space in the new shops to anything like a temperature of + 15° C. The cast-iron radiators are of Michel Perrets system, 20 in number in the erecting shop, with a heating surface of 23 square metres each, besides one of 6 square metres in the machine-tool department and one of 3½ square metres in the erecting foreman's office. Each one has a Hemtz system purge or drain cock. As the boiler pressure is 8 kilogrammes per square centimetre, a reducing-valve with relief-valve (Legat's) is provided for lowering the pressure of 3 kilogrammes per centimetre square. However, against the contingency that the reducer ever ceased to work, all the radiator pipes are tested by water up to 9 kilogrammes per centi metre square and safety-plugged for a limit pressure of 6 kilogrammes per centimetre square. With this heating system the temperatures recorded during trials and taken at a height of 6 feet 6 inches from the floor were as follows:—

Outside temperature.	Inside temperature.		Rise of temperature.
— 10° C.	+ 5° C.	=	+ 15° C.
— 5° C.	+ 7° C.	=	+ 12° C.
0° C.	+ 10° C.	=	+ 10° C.

Steam Transmission.—The steam is transmitted from the boilers to the various shops, both for motive power and for heating, by means of overhead pipes supported through the distances intervening between the shops by suspension cables hung in the manner usually adopted for bridging wide spaces. There is a total of 280-metres length of steam mains, and the most important consideration with regard to the installation of this was the employment of an efficient non-conductor of temperature. No silk is used for this purpose, the principal non-conductor being the thickness of 3 centimetres of a mixture composed of goat's hair 1.5 per cent., best quality refractory earth 40 per cent., refractory sand 25 per cent., moistened with water, for mixing, up to 53.5 per cent. Around this layer is bound soft cord soaked in yellow earth followed by more coils of soft cord or of straw bands soaked in brick-earth mortar containing 10 per cent. of horse droppings, the winding of the coil being tightened up towards the outer layers. This is all thickly covered up with mortar and then incased in three-ply pitch-paper followed by a layer of tar over which is wound from one to three coils of osier rope. Where the pipes pass outside the buildings there is a protective covering formed of a number of layers of thin canvas, followed by several thick coats of linseed oil (1 part) mixed with black lead (half-part).

Hygiene.—In all Continental locomotive shops the hygienic pre-

cautions taken where a great number of work people are massed together are on the whole generally good, although not all of these are so elaborately contrived as are those of, say, the State Privileged Locomotive Works near the Sudbahn Station in Wien. At Epernay the lavabos are provided in the erecting shop itself, and consist of long troughs which drop down, when required, from their vertical position against a roof column and then provide place for 8 to 10 men at each one. The floor beneath is of brick, which is soft enough not to injure a piece of work that may by accident fall.

For the supply of pure drinking water the river Marne was to be avoided as a source, so tube wells were driven to a depth of 50 feet into the middle of the chalk stratum and 30 feet above the alluvial beds, so that any injurious infiltrations were not possible and microbiological analysis proves the water-supply to be excellent. This water is pumped into reservoirs, and concentric cisterns or drinking fountains are conveniently located in the shops, the outer envelope serving to keep the inner one cool—although it has yet to be learnt that warm water is a better thirst-quencher and less injurious to the system and besides a saving of the workman's time. In summer-time extract of coffee is put into the inner vessel, and this tempers the chilled water much as would the English workman's oatmeal drink.

A telephone connects all the workshops and the whole of the works is equipped with fire-alarm bells which, in emergency, would sound all together with the works "tooter." There are also motor alarms working between the engine room and the shop motors.

Educational.—At Epernay there is an admirably-organised school for apprentices and the courses of instruction given, as shown by the programme which includes elementary mathematics, are really excellent in every respect. The "class-room," however, has not the imposing appearance of some similar institutions on the Continent, as for example the apprentices' class-room of the Hungarian State Railway Works at Budapest and at Diosgyor. In the shops these lads whose minimum age is 13 years have a working department to themselves—a "nursery"—where they are in the care of proficient mechanical instructors. Instructive examples of vice-work are hung up on the walls of their shop, and adjoining this ward there is a lavatory where the apprentices can also learn habits of cleanliness both in going from and coming to their work.

In concluding these notes I desire to acknowledge my indebtedness, while visiting the works, to the courtesy of M. Desjeans, the chief engineer, and of his assistant-engineer, M. Fort.

ENGINEERING EXPORTS OF BRITAIN, GERMANY, AND THE UNITED STATES.

By W. Pollard Digby.

This article concludes Mr. Digby's analytical study of export-trade statistics. It began in our issue for June last, and took up first the trend of supremacy, as disclosed in the general situation, and next the relative importance of the three great manufacturing nations in each of the most valuable markets for export trade. The graphic method of presenting results adopted by the author makes his conclusions and deductions particularly easy to grasp.—THE EDITORS.

IN preceding articles we have reviewed the general situation as it affects export trade in engineering manufactures, and have traced the trend of advance or retrogression of the three great manufacturing nations in the most important trade zones. It remains, before a general summing up, to consider the conditions in certain remaining regions which are specially related to Great Britain by colonial ties.

West Indies and Adjacent Countries.—Passing northward from the great South American continent, we come to the somewhat scattered group of countries which comprises the West India Islands, Mexico and the various Central American republics. The bulk of the trade is overwhelmingly American, as is shown by the following figures:

Year. Ex	1899.	1900.	1901.	1902.	1903.
	In thousands of pounds sterling.				
United States	2,520	4,096	3,992	3,669	3,422
United Kingdom	1,114	1,179	1,013	1,331	1,092
Germany	335	455	512	827	735

Mexico, Cuba, and the British West Indies form the chief purchasing groups, the respective total exports to these three markets being shown in Diagram No. 1. Mexico makes the largest purchases from each country—proximity accounting for the largeness of the American trade. The Cuban trade is also in American hands, the British trade in engineering articles being quite small. The German trade to Cuba is even smaller, and cannot be represented on this diagram. The same remark applies to the German trade to the British West Indies, where British trade is in excess of that from the United States. The chief items of American exports to Mexico are shown under three headings in Diagram No. 2, from curves repre-

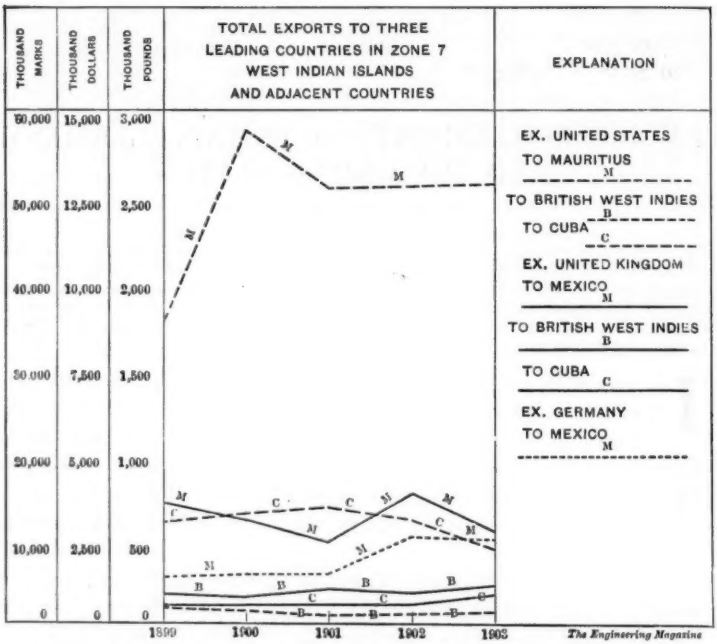


FIG. I. TOTAL EXPORTS TO MEXICO, CUBA, AND BRITISH WEST INDIES.

senting the respective exports from the United Kingdom and Germany under two headings. The American machinery export is a very large one. Unfortunately the American returns of trade with Mexico do not classify it under sub-headings.

British North America.—The Dominion of Canada affords to the United States the chief market for engineering manufactures. Whereas goods from the United Kingdom can only enter at a few ports after a journey across the Atlantic, the railways which cross and recross the frontier can often bring material from American industrial centres at as cheap a rate as from the port at which a ship can discharge its cargo. The following are the figures of the total trade:—

Year. Ex	1899.	1900.	1901.	1902.	1903.
	In thousands of pounds sterling.				
United States	3,028	4,384	4,664	4,657	5,035
United Kingdom	1,253	1,242	1,321	2,251	2,558

Second place is held by the United Kingdom, which has the slight advantage in the rebate of one-third of the customs duty paid on goods from other countries. Added to advantages of language, this is an

important factor so far as competition between the United Kingdom and Continental countries is concerned. In competition with the United States this concession is of very little avail, as is evidenced by the foregoing figures, which show that while British trade has increased by £1,200,000, American trade has increased by £2,000,000. Diagram No. 3 shows the chief items of exports to Canada. As regards the increase of British and decline of American exports of iron and steel wares (other than machinery) generally, in 1902 and 1903, it must be remembered that these were years when exports from the

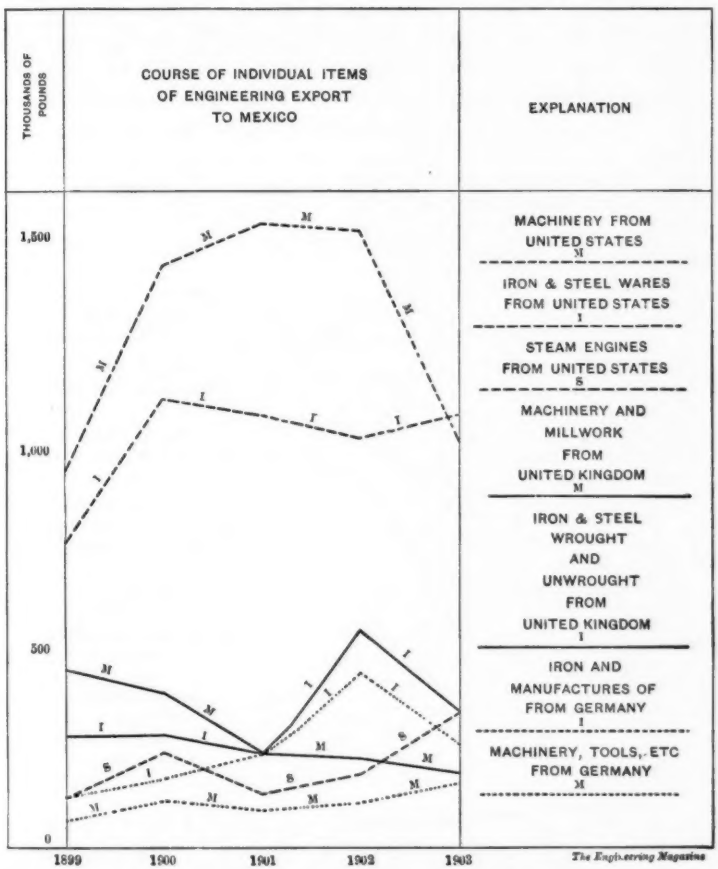


FIG. 2. FLUCTUATIONS IN EXPORT TRADE TO MEXICO.

United Kingdom to the United States were exceptionally heavy, owing to the great local demand.

British America.—The general rule—to which British North America is the one exception—that British exports to British colonies and dependencies are in excess of those of the United States or Germany, holds good with regard to British South Africa, and the scattered possessions on the East and West African coasts. The following figures give the total trade:—

Year. Ex	1899.	1900.	1901.	1902.	1903.
	In thousands of pounds sterling.				
United Kingdom	2,733	2,718	3,420	5,887	7,731
United States	794	390	513	639	885
Germany	360	248	342	610	907

The above table is one which would admirably lend itself to manipu-

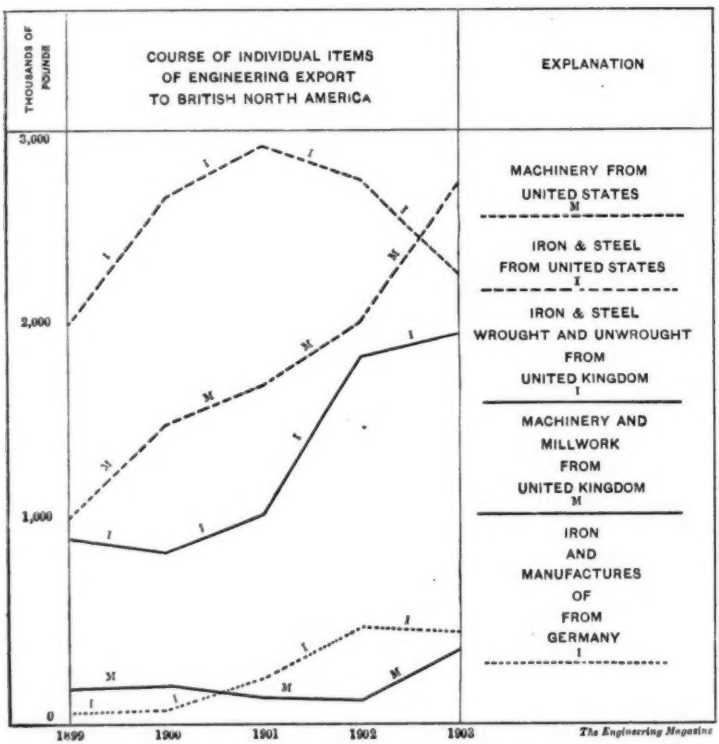


FIG. 3. COURSE OF PRINCIPAL ITEMS OF ENGINEERING EXPORT TO CANADA.

lation by a particular section of students of British statistics, who seek in statistical "facts" ammunition for a political campaign. It would certainly be a fact to state that if the exports of each country in 1899 had been taken as 100, the British figures would only show an increase of 134 per cent. to 234, while the German figures indicate an increase of 152 per cent. to 252. Yet in the one case the increase of 134 per cent. of the 1899 trade represents an increase of nearly £4,400,000, and in the other case the increase of 152 per cent. represents an increase of only £547,000. This digression into the realm of English politics is scarcely pertinent to the subject, but the practice in question of selecting an absolutely arbitrary date, and assigning an equal numerical value to widely differing sums of money or quantities of material, has been used in quarters of such importance that this digression may perhaps be pardoned.

In Diagram No. 4 are shown graphically, under certain comprehensive headings, the exports to British South Africa from the United Kingdom and Germany. These tell their own tale, and do not call for comment. No curves are given of American trade, partly on account

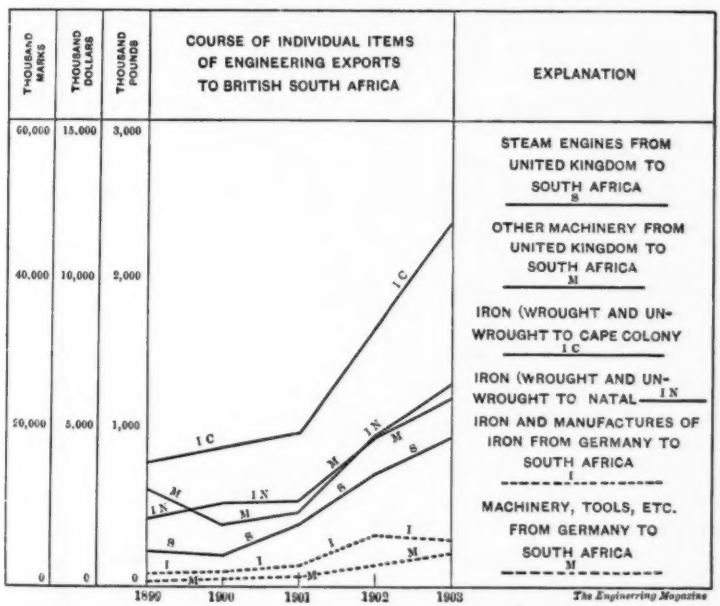
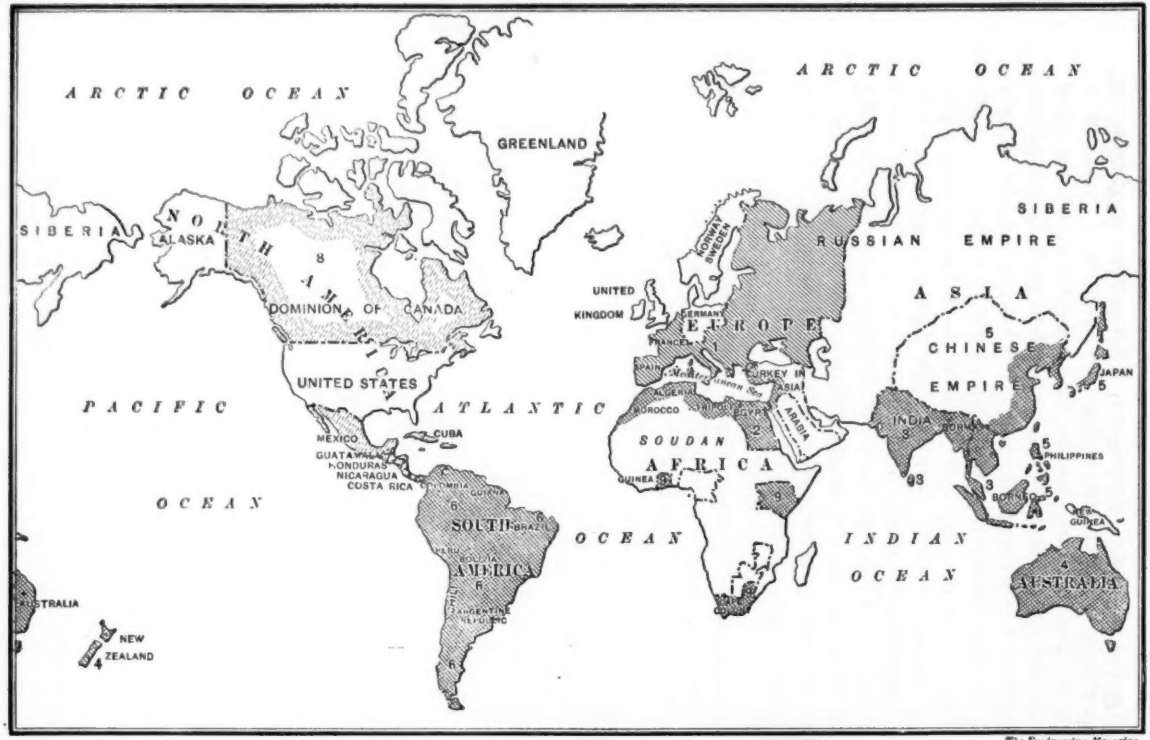


FIG. 4. THE TENDENCIES OF ENGINEERING EXPORT TRADE TO SOUTH AFRICA.



The Engineering Magazine

DISTRICTS IN WHICH BRITISH TRADE PREDOMINATES
" " " GERMAN " "
" " " AMERICAN " "

FIG. 5. A GRAPHIC CHART OF BRITISH, GERMAN, AND AMERICAN DOMINANCE IN EXPORT TRADE.
The trade-zone numbers correspond with those used by Mr. Digby in the body of his article.

of its relatively small volume, and partly because the American returns do not distinguish trade to South Africa from trade to the rest of the British possessions in Africa.

Reference to the map (Diagram 5) which appears on the opposite page, will shew at a glance the nationality of the country exporting the greatest quantity of engineering goods to each of the nine trade zones into which I have—perhaps empirically—divided the world. Each manufacturing country is, of course, supreme within its own borders. Passing beyond these, British engineering articles are first, in regard to (2) the southern and eastern Mediterranean seaboard, (3) the British East Indies, (4) British Australasia, (5) the Far East, (6) South America, and (9) South Africa. Germany is pre-eminent on (1) continent of Europe as a whole; and the United States is foremost in regard to (7) the West Indies and adjacent countries, and (8) British North America. In the three cases where Great Britain is not first, she takes second place—in each case by a very substantial margin. While this map—which would apply to any of the five years covered by this review—indicates the nationality of the manufacturers who are supreme in supplying each particular zone, too much emphasis must not be laid upon its indications. Thus, while the United Kingdom takes second place in regard to European trade, the margin between the volumes of British and American trade to the eight countries of this zone would more than suffice to cover the entire value of the American exports to British North America, plus half the value of the American exports to the British West Indies, the two zones to which American exports predominate. In order, therefore, to represent the volume of trade to the chief zones in the last year of the period under review, the final diagram (page 680) has been prepared, which conveys in the most easily recognizable form an idea of the importance of the exports to the chief zones in 1903.

It may perhaps be urged that the values taken throughout this review of engineering trade—export values at the port of the country of manufacture—should not have been taken, but instead the values at the port of discharge. To obtain these latter figures would have been a task of much difficulty, and the values registered would in each case have been swollen by costs of transport, the profits of which would go, perhaps, to the ship-owners of another country. Taking the prices at the port of shipment, therefore, represents more closely—but not absolutely—the importance to the manufacturer of the different markets. Also, in several cases, such as certain British colonies and certain South American countries, no distinction is made between

goods of British manufacture and foreign-made goods re-exported. The official export values have therefore been taken. These do not in every case embrace absolutely identical goods, but any involuntary omissions of various items would not greatly swell the figures of any particular country. Every care has been taken to reduce these omissions to a minimum, but considering that these summaries have been prepared from items abstracted from trade returns embodied in something like seven thousand foolscap pages of statistics, some small omissions are almost certain to have occurred.

It is greatly to be regretted that commercial statistics generally are of so one-sided a character. On fluctuations of import and export statistics many hypotheses are advanced. In the case of a country absolutely without manufactures such figures are sufficiently satisfactory. But in the case of any large manufacturing country, such as those whose export trade has been considered to reduce prosperity or the reverse from figures of export or import trade, is a proceeding dangerous on account of its mere superficiality. Internal trade statistics are lacking in all but a few instances. As regards even these few instances, the majority are the results of figures collected by individuals or associations of manufacturers, and lack the hallmark of an impartial government authority. If the value of the output of the manufactured goods in certain well defined industries were computed with half the attention given to statistics of import and export trade, the fiscal problems of various countries would admit of an easier solution, and paths of doubtful economic sanity would no longer be pointed out by the blind leaders of a blind electorate as the road to national wealth and supremacy. The telescope *per se* is an excellent instrument, but to confine mankind to its use, or to keep a pair of binoculars glued to each pair of eyes, would not

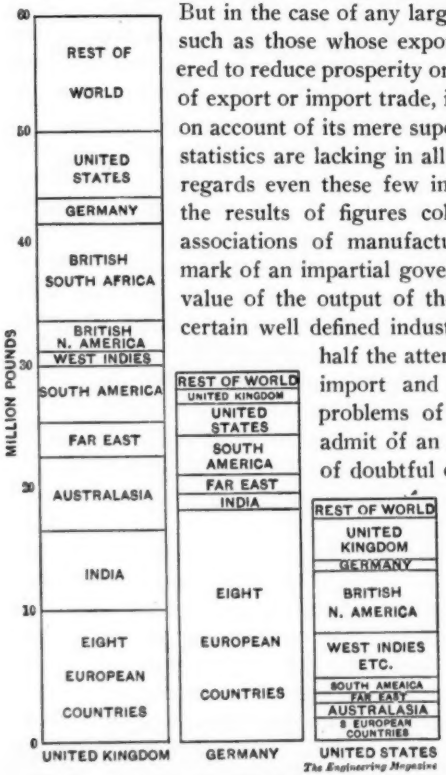


FIG. 6. VOLUMES OF EXPORT TRADE IN 1903.

aid the race in its dealing with all the nearer, but by no means minor, happenings of life. Virtually, figures of imports and exports are a telescope vividly showing the minutiæ of over-sea trade. The community requires a statistical microscope, wherewithal the internal prosperity of a country may be examined in detail. It must be clearly understood that I do not despise figures of export or import trade. These require careful study as showing the manner in which any country not producing sufficient food stuffs for its population secures these, or in which capital in the shape of exports goes to an undeveloped country; or in which a capitalistic country receives the income on, or repayment of, a portion of its investments. If to a knowledge of the great trends of capital and industry, exemplified by import or export returns, is added the knowledge of the conditions of industrial trade, all the facts are at hand and the politician can enunciate axioms rather than theorems at present often incapable of proof.

Even if internal trade be ignored, the volume of external engineering commerce dealt with in this review is that of a complex but opulent nature. If the sense of civilization forbids internecine war between occidental nations, international competition still remains. In this industrial warfare brain power and intelligence will be—nay, must be—the dominating feature. It is recorded of that stalwart and genial soldier, Blücher, that his first impression of the London of his day was an overpowering sense of its tremendous wealth. "What a city to sack!" the descendant of the wild Teutonic tribes, who had extorted tribute from Imperial Rome, is said to have exclaimed. Today the very extent of British commerce gives rise to a similar feeling in the mind of manufacturers descended from Blücher's soldiers. The great contests will range around the neutral markets. To secure or increase a hold on these demands smooth working among many conflicting factors in each competing country. Some of these may be suggested, such as abundance of local supplies of raw material, or capital to exploit distant sources, together with a fiscal system admitting semi-raw or semi-manufactured material free of taxation. Of importance also is it that the artizan class should be sober, industrious, and intelligent. The manufacturer, who is the general of a division in the army of industry, needs to be equipped, not only with scientific knowledge, but with shrewd business instincts of organisation. In all countries certain of these properties are possessed to a very high degree; indeed in America and Germany intelligence departments are at work to aid the manufacture, but in several

their reports are ignored. As an Englishman, I cannot but remember that one of the traditions of English history has been that in nearly every war opponents have been despised and contests have been entered upon in a state of utter unpreparedness. I take comfort in remembering that when once my country has felt a reverse, the tonic properties of that rebuff have helped it to do rather more than "muddle through." Challenged in several markets, displaced in some, the British manufacturer will set his works and machinery in order, and although modern conditions prevent his maintaining an absolute manufacturing monopoly, he will yet retain the lion's share of the world's engineering commerce, even in competition with German thoroughness and American energy, and despite American superiority as regards supplies of engineering raw material.

TEMPERATURES IN AIR AND AMMONIA COMPRESSOR CYLINDERS.

By Leicester Allen.

IT is somewhat remarkable, as we review the field of engineering activity, to find so many indeterminate factors the values of which must be assumed in our investigations and in our actual work. When dealing with such factors, individual judgment is compelled to take the place of experimental data, with more or less chance for errors in final results. One of these indeterminate factors is the mean temperature of the interior of an air-compressor cylinder, taking in air at a stated temperature and pressure and discharging the air at a stated presure. Does any one exist who could guarantee that from these data he can mathematically determine more than an approximation to the temperature of the air so discharged? Such an approximation may be all that is required for ordinary practice in building and operating compressors, but it does not meet the requirements for the scientific investigation of some of the problems of air and ammonia compression.

Take, for example, a case wherein a very high pressure is desired to be attained, space and cost also imposing the condition that the compression be accomplished in as few stages as possible, without producing excessive temperatures in the cylinders. In dealing with such a problem, we have of course the well established thermodynamic formulæ; but their use gives us theoretical results only, never attainable in practice. When we test by thermometers the temperature of compressed gases as they pass from the compressor cylinders, we find a wide discrepancy between the thermometrical readings and the theoretically calculated temperatures. We usually account for these discrepancies by attributing them to loss of heat by conduction through the walls of cylinders. We have never been able to find yet a perfectly non-conducting material of which to make, or with which to insulate, compressor cylinders, and so a notable fraction of the heat that would otherwise accumulate in the cylinder walls and the contained air escapes.

Now with very exact thermometrical work, we can quantitatively determine such escape by subtracting the heat contained in the dis-

charged gas from that which it should theoretically contain as computed by the accepted thermodynamic formulæ; but having so found the transmitted heat, we still confront the question of the mean temperatures of the cylinder walls, cylinder heads with their valves, and the piston with that part of the piston rod which alternately works within and without the cylinder space.

These temperatures have a fundamental importance in the consideration of the subjects of cylinder condensation in reciprocating steam-engines, of superheating in ammonia compressors, and of such ratios of compression in air compressors as will be consistent with safety in their practical operation. One of the dangers in air compression which has not been fully recognized until within a quite recent period is the liability to explosion of air-compressor cylinders when the heat of compression is caused to exceed the flashing-point of the oil used for cylinder lubrication. Several more or less serious accidents of this nature have been recorded within a period of three or four years.

The interior temperatures of the metal of steam cylinders, pistons, and heads, have been experimentally determined for special cases, with a probable approximation to accuracy, but I know of no such experimental determination for air and ammonia-compressor cylinders. As related to the question of superheating in ammonia cylinders these interior temperatures are important.

In the introduction to the admirable translation of M. Ledoux' "Ice-Making Machines" by Professors J. E. Denton, D. S. Jacobus, and A. Riesenberger, page XXIX, Fifth Edition, Revised,—speaking of ammonia compression ice-machines, it is said:—

> "In compression machines employing volatile vapors, the principal cause of the loss of the theoretical result * * * * is the heating of the ammonia, by the warm cylinder walls, during its entrance into the compressor, thereby expanding it, so that, to compress a pound of ammonia, a greater number of revolutions must be made by the compressing pumps than corresponds to the density of the ammonia gas as it issues from the brine tank."

The statement quoted is based upon experiments actually made in a most careful manner by Professor Denton, the results of which are tabulated, on a folding sheet inserted between pages XVIII and XIX of the introduction. The volume of the condensed liquid ammonia, if there were neither loss by superheating between the brine-tank and the pumps, nor in the pumps themselves, should be exactly proportional to the volume of gas drawn into the pump at each stroke. In Professor Denton's experiments the volume of the liquid was found to be much less per stroke than it would have been had the same cylinder volume

of gas been inducted at the temperature of the suction. As nothing is known that can lessen the weight of a given volume of gas except expansion, and as heat is the only possible known force by which, under the conditions, a gas can be expanded, and as the weight of the gas entering the pump must be exactly equal to the weight of the liquid resulting from the condensation, and this weight is a constant exact function of the liquid volume at any stated temperature, the inference drawn by these writers that the principal loss of theoretical result is due to superheating seems perfectly logical. Now, if the superheating be wholly caused by the contact of the gas with the previously heated cylinder walls, it follows that a system of compression which heats the cylinder less, will superheat the gas less, such superheating being a function of the difference of the temperatures respectively of the interior cylinder surfaces and of the gas. Such a system is the compound system of compression in two stages, with cooling after the first stage. The resulting temperature of a gas compressed adiabatically is a function of the ratio of compression. If the compresion be effected in two stages, with equal ratios of compression, each ratio will be the square root of the total ratio, and the application of the accepted thermodynamic formula for determining the final temperature of compression for any particular ratio of compression (the absolute temperature of the gas at the beginning of the compression being known) will show that the maximum final temperature will be much less in the two-stage, than in the single-stage system.

Ammonia, as it enters the compressor, in what is called dry compression, is either a saturated or a superheated vapor. Zeuner has supplied a formula for computation of temperatures of superheated vapors for any ratio of compression, and this is general for ammonia and for all condensible gases; and it is universally admitted that unless some liquid ammonia is passed into the compressor with the gas (wet compression), the gas at the beginning of the suction period will nearly always be slightly superheated. Assuming that in dry compression the gas is superheated slightly before it reaches the suction valves, in any case of dry compression the application of Zeuner's formula will theoretically determine the final temperature for any suction temperature and compression ratio. Air is, of course, in its normal condition, a mixture of superheated vapors.

Now it is plain that the interior of the cylinder can never reach a higher temperature than that of the gas at the end of the compression. The material warmed by contact can never become warmer than that

which warms it. This is a fundamental law of heat transmission. It is also plain that a surface alternately exposed at equal and short intervals, first to a medium hotter, and second, to a medium colder than itself, must take, and substantially retain, some average temperature between the extremes. When the extremes are constant, it might plausibly be expected that the intermediate temperature would be the mean of the extremes.

The temperatures at different periods of the operation in Professor Denton's experiments are tabulated on page XXXIV of the introduction to the work already cited. In the suction pipe, just prior to entering the cylinder, the absolute temperature of the gas was 485 degrees F.; at the end of the suction it was computed to be probably 617.6 degrees F., the gas having been superheated 132.6 degrees; at the end of the compression it was 995 degrees F. The extremes of temperatures to which the interior surfaces of the cylinder were subjected are therefore 995 degrees and 485 degrees absolute, the mean of which is 740 degrees absolute. Assuming this to be the substantially average maximum temperature attained by the metal surfaces, we can reason as follows:—

Since the metal can give off to the cooler inflowing gas during one revolution of the compressor crank no more heat than it receives during one revolution, while working uniformly, and while the gas gets warmer the metal gets cooler, the greatest possible superheating would be at the instant whereat the metal surfaces and the gas, the former by cooling and the latter by heating, mutually and simultaneously arrive at the same temperature. In neither the gas nor the metal is there any other known physical change during the superheating of the gas. If sufficient time for transmission of heat from the metal to the gas be allowed, the temperature will inevitably equalize in both. The weight of the metal cylinder with its piston and heads is enormously greater in comparison than the weight of the gas, but its specific heat is only about one-fourth that of the gas. Approximately, the cooling of any weight of cast iron through a given range of temperature would effect the heating of one-fourth of the same weight of ammonia through an equal range. The conclusion that only a very thin interior stratum of the iron is concerned in the cylinder superheating of air or ammonia, while entering a compressor cylinder, or in the cylinder condensation of steam during induction, has been generally accepted, and the preceding considerations render it probable that this view will never be successfully disputed. But the metal heats throughout its entire mass,

notwithstanding. The action of a steam jacket is to lessen cylinder condensation by transmission of heat from the exterior to the interior surface. So the action of the cold-water jacket almost universally used on air and ammonia compression cylinders tends to lessen the superheating, but the transfer of heat from surface to surface proceeds in an opposite direction.

The quantitative effect of the cold-water jacket in lessening the superheating has not been made the subject of such thorough investigation as has been devoted to steam jacketing, and few, if any, reliable data upon which to base conclusions are available. But, when cool water in considerable quantity is constantly passed through the compressor jackets and issues therefrom with a notable elevation of temperature, it is sure that the effect of this transfer of heat from the inner cylinder surface through the cylinder barrel and heads, and thence to the water, must diminish, in a greater or less degree, the temperature of the inner surface, and so decrease its power to superheat.

Professor Denton's experiments were made with a seventy-five ton ammonia dry-compression machine. No one who has read his paper describing these tests in the transactions of the American Society of Mechanical Engineers, will question the skill and care with which they were conducted, or will dispute his determination of the superheating, 132.6 degrees F., as a matter of fact. We have already seen that, to account for this wholly by transference of heat to the gas from the interior cylinder surface, this surface must have an average absolute maximum temperature of 740 degrees F. at the beginning of the suction. The inflowing gas had a well ascertained absolute temperature of 485 degrees F. Suppose an interior stratum of the metal at 740 degrees falls in temperature through the same range as the gas is superheated. Then, at the end of the suction and just prior to the beginning of compression, the absolute temperature of the superheated gas is substantially the same as that of the cast iron in contact with it, and such temperature will be the mean of 740 degrees and 485 degrees, or 612.5 degrees, which accords remarkably with the absolute temperature, 617.6 degrees, in Professor Denton's table.

But if a notable quantity of heat is constantly passing out from the inner stratum of metal into the jacket water, it is certain that the temperature of that stratum cannot be a mean of highest and lowest temperature of the gas in the pump, and that a part of the superheating must be accounted for by another cause, or causes. Such

causes may be found in the friction of the pump-rod and piston, in the constant beating of the poppet valves on their seats, and the friction of the gas itself in passing through ports. We cannot accept these causes as sufficient in the aggregate to counterbalance the cooling by the water jacket. Professor Denton's determination was 713 British thermal units per minute removed by the jacket in the experiments under consideration; and the mechanical equivalent of the heat so removed was 554,714 foot-pounds per minute. The power of the steam-engine was 2,395,800 foot-pounds per minute, and the total friction of the machine 18.6 per cent., or about 445,619 foot-pounds. It becomes evident from these figures that the heat removed by the jacket is in excess of that generated by the total friction of the machine, and therefore must be far in excess of the heat generated by the several frictions which can be possibly associated with the superheating of the gas during the suction period. The fact and the degree of the superheating are indisputable. The inference is irresistible that the principal cause is the transfer of heat from a thin interior stratum of the metal in contact with the gas; but the inference that other causes contribute to the observed results, seems equally unavoidable. It is impossible to conceive that, by simple contact, or any effect of radiation, the gas can ever be superheated to a temperature higher than a mean between the average temperature of the metal which imparts the heat and the minimum constant temperature of the gas during the inflow. It is impossible to conceive that, with a water jacket taking away 713 British thermal units per minute, the gas is superheated to even this degree. Of course a large percentage of the heat removed by the jacket is heat generated by the mechanical work of the compression, but during the suction period, the entire pump barrel being surrounded by cold water, we cannot be justified in supposing that the effect of jacket cooling in reducing the temperature of the inner surface is so small as to be negligible.

The subject involves many experimental and theoretical difficulties. Some recent experiments (which, at present, it is not permissible to cite more specifically) made to determine the extent to which a two-stage compound compression with intermediate cooling would lessen superheating, as compared with that in a single-stage compression system, have demonstrated that there is less superheating in the two-stage system; but the results were not so conclusive as expected, and further experiments will be needed before any reliable data can be deduced.

MODERN POWER-PLANT DESIGN AND ECONOMICS.

I. A COMPARISON BETWEEN AMERICAN AND EUROPEAN PRACTICE.

By Franz Koester.

The current portion of Mr. Koester's study covers the general features of the design of large power stations—that is, the location, design of the structure, adaptation to the type of machinery selected, etc. Succeeding portions will discuss in detail the boiler-house and engine equipment. Mr. Koester has been intimately connected with power-plant construction both in Europe and America, and has undertaken this review at the request of a number of engineers specializing in this work. The contrast between American, British, and Continental practice which runs through his discussion will be found of much interest; more important still, perhaps, are his indications of the possibilities of enormous savings in coal and water consumption, and his argument for more scientific methods of design and better guarantees on the part of manufacturers.—THE EDITORS.

SINCE the general commercial adoption of electricity for lighting, railways, mining, smelting, and many and various other enterprises, a marked development in the central-station power plants has taken place. These power plants generate electricity from prime movers driven either by steam or by water. Power of the latter sort may be easily obtained in mountainous countries, such as California, Switzerland, Sweden, etc., where the energy is collected from the mountain lakes or streams, or at such falls as that of the Rhine, Niagara, or that on the Zambesi, the "Victoria Fall," the greatest in the world, where some 25,000,000 horse power may be easily developed. Although it is possible to-day to transmit electricity considerable distances from a central source to innumerable consumers, unfortunately there are so such water powers situated near the large cities, where the greatest demand for electric power exists. Take, for instance, the cities of New York, Chicago, London, Paris, Berlin, Vienna—all of which are obliged to generate electricity from the former source, i e, the production of steam from the latent energy in coal, and the utilization of that steam in generating power for either mechanical or electrical purposes.

The design of these steam power plants involves the study of a great number and variety of engineering apparatus, and it is therefore properly considered a special branch in itself. In Europe, especially

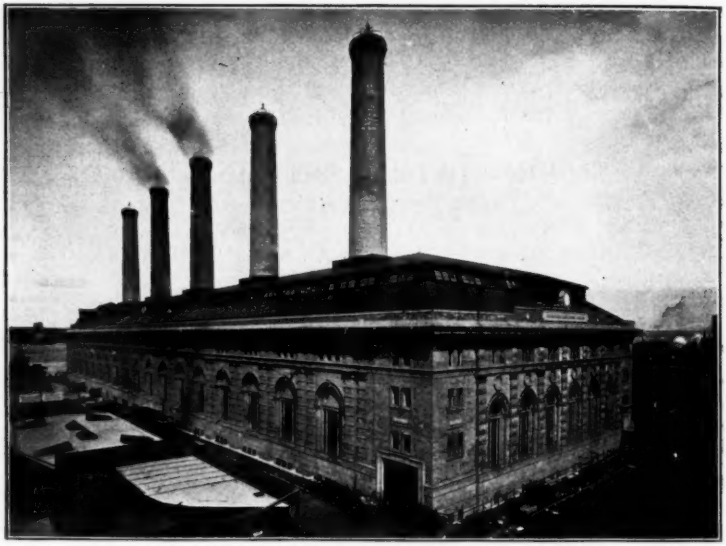


FIG. I. THE INTERBOROUGH COMPANY'S NEW POWER HOUSE FOR THE NEW YORK SUBWAY.

on the Continent, where engineering work is strictly classified, and often by very definite lines, power-plant designing is a vocation of itself, the benefit of which in many instances cannot be overvalued as will be seen later. Quite different is the practice in the United States. Although there are many American engineering offices where the design of power plants is carried on, some of the most prominent plants in the country have been built by newly formed construction companies, employing one or two experts while the remainder of the force consists mostly of men untrained and inexperienced in this manifold branch of engineering. Could it be expected that a steel constructor, no matter how experienced, could design as economical or efficient a power plant as one who has devoted his entire time to this particular line of practice? It is natural that only a staff of engineers and draughtsmen specially trained in this line could assure the most skilful and thorough construction, not to speak of the scientific knowledge necessary for such an undertaking in order to secure the most economical results in operation. The question forces itself upon us why, on the continent of Europe, in a modern plant, a steam consumption of only 9 to 10 pounds per indicated-horse-power hour is obtained, while in England and Amer-

ica a consumption of 13 to 15 pounds is considered good practice. This superiority of some 50 per cent. on the part of the Continental plants may in certain cases be explained by the above mentioned facts, while in part it is due to the manufacturer and the power-plant manager.

The author, having had direct experience in the design of both small and large power plants, on both sides of the Atlantic, will endeavor to describe modern power-plant practice. The discussion is presented in fulfilment of the request of several power-plant engineers, who have desired especially a comparison between the design and the efficiencies of American and European plants.

Before the adoption of alternating current, when direct current was transmitted throughout the city, it was necessary to have the plant centrally located in order to facilitate a proper and uniform distribution. It was often found necessary to build several smaller plants to supply a single railway or lighting system. A good example of this is supplied by the city of Hamburg, 650,000 inhabitants.

FIG. 2. THE BARMBECK PLANT IN HAMBURG, GERMANY.

Here the Schuckert Company built for the Hamburg Elektricitäts Werke no less than five plants, located at proper distances apart and directly in the city. The aggregate output of these five plants is some 50,000 horse power, which today would be considered not excessive for a single plant. It must be remembered that some of

these plants served the city with power and lighting at an early date, and in order to avoid changes in the existing equipment the same system was followed in the later plants.

With alternating current at high voltage, it is easily possible to supply large cities from a single generating plant. In northern Italy, the Valtellina Railroad with its present length of some 70 miles is supplied with power from a single source at 20,000 volts, 15 cycles. As we have today plants of 100,000 horse power and more (the New York Subway plant (see Figure 1) will have a maximum output of more than 130,000 horse power) it will be seen that the tendency

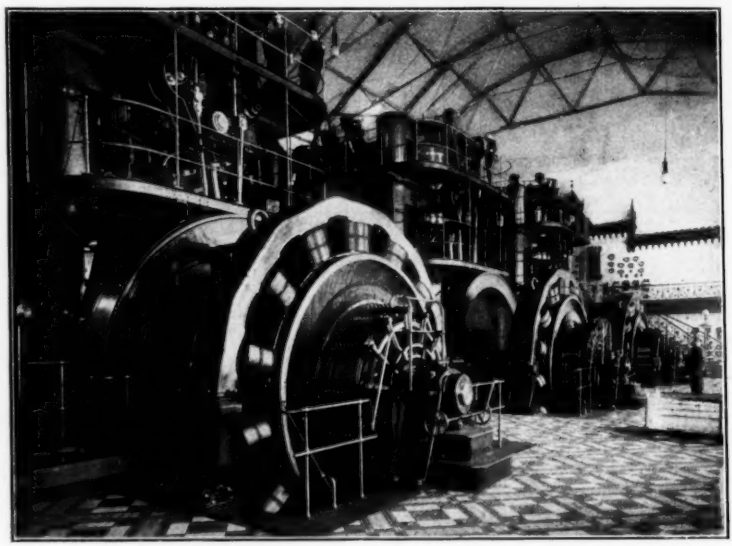


FIG. 3. ENGINES AND GENERATORS IN THE BARMBECK STATION, HAMBURG, GERMANY.

Schuckert & Co., Nurnberg.

is toward the adoption of a single central station. Not only has the size of the power plant been increased, but also the main units, steam turbines of 10,000-horse-power capacity being installed by the Brown Boveri Company to supply power and light to the city of Essen, Germany, and as I am informed, there are still larger turbine units in course of construction. The city of Vienna will in a short time have two 10,000-horse-power steam turbines installed in its municipal plant. Not only in turbine units has this enormous increase in size occurred, but as I understand, the Allis-Chalmers Company have submitted

FIG. 4. THE MUNICIPAL ELECTRIC STATION, MUNICH.

bids for 10,000-horse-power reciprocating engines to the New York Central & Hudson River R. R. Company. This is not the place to discuss the respective merits of the different sizes of prime movers, there being special features which must be taken into consideration for each special case.

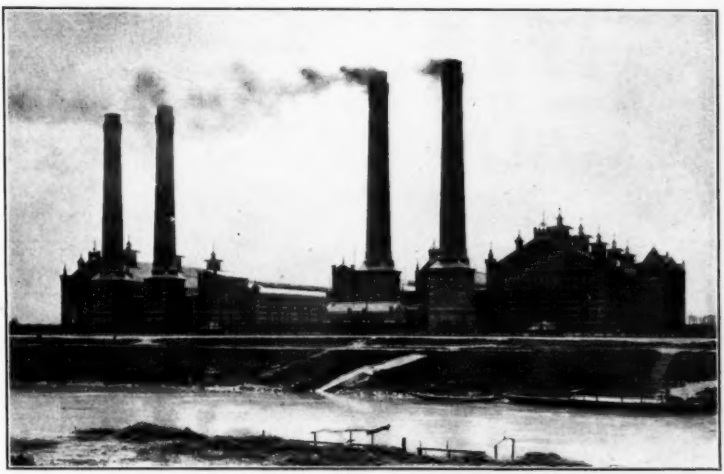


FIG. 5. THE MUNICIPAL POWER STATION, VIENNA.

The location of the plant itself must be chosen, first, as close to the water front as possible, and second, with respect to the possibility of a railroad siding, these provisions being necessary for the economical handling of machinery, coal, etc. Not only does proximity to the water front allow of cheaper transportation, but a still greater convenience is the accessibility of a sufficient supply of water for condensing purposes, which in large plants is no small item; and further, when this water is fit (either directly or after purification) for boiler-feed water, an enormous saving in cost of maintenance accrues. By the use of alternating current the plant may even be located in a suburb, where land is cheap; but it often happens that the designer is forced to locate the plant directly in the city, causing in many cases a deterioration in the value of the surrounding property. While city land on the continent of Europe is comparatively cheap, many plants are found in the suburbs; in either case the engineer has to build a plant to suit the artistic tastes of the resident property owners as well as himself. The accompanying illustrations will furnish ample examples. The Hamburg plants, Figure 2, are all in the city. The municipal plants of Munich, Figure 4; Vienna, Figure 5; and Mainz, Figure 6, are all in the suburbs and speak for themselves. Not only do the exteriors of these European plants present an artistic effect,

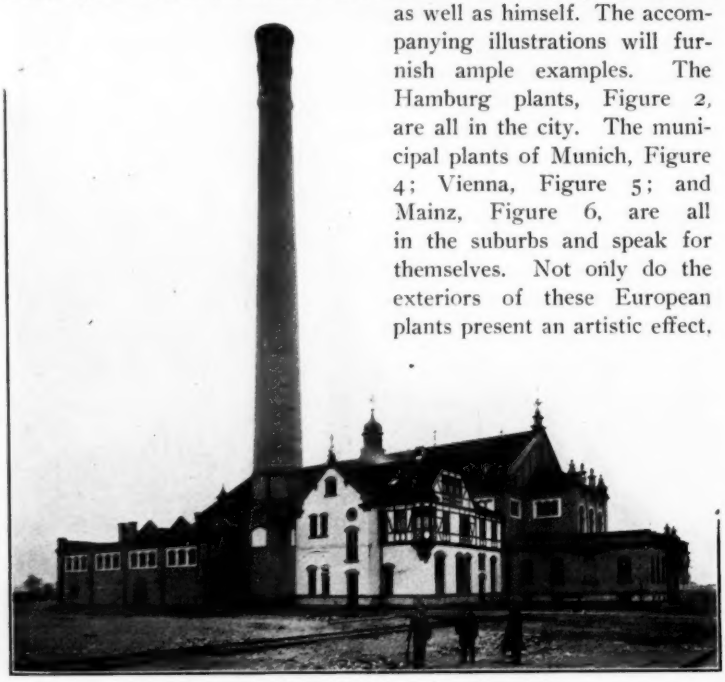


FIG. 6. MUNICIPAL PLANT AT MAINZ, GERMANY.

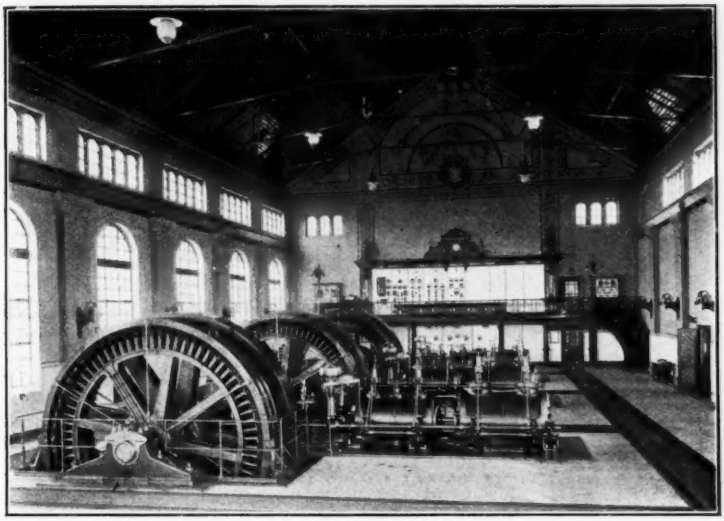


FIG. 7. GENERATING SETS IN THE MUNICIPAL POWER STATION, MAINZ.

but the interiors also present a pleasing appearance as will be seen in Figures 3 and 7, as well as in other illustrations.

A still more important consideration is that of the smoke nuisance, which, however, may be entirely overcome by the use of properly designed smoke consumers. Complete combustion in the furnace is now attainable, and this in addition to overcoming of the smoke nuisance also increases the efficiency to such an extent as soon to pay for the additional first cost of the apparatus.

The most favorable arrangement, here as well as abroad, has been found to be the location of the engine room and boiler room side by side, thus allowing in most cases the shortest steam-pipe runs, as well as many other advantages. By placing the boiler and engine rooms end to end, a long steam run is involved, and this is one of the greatest disadvantages, especially where superheated steam is employed. With the adoption of the steam turbine as the prime mover, making a compact layout, the turbine room is much smaller than the boiler room, provided the much used horizontal water-tube boilers are installed. In Europe as well as in America, in the design of steam-turbine plants, owing to the possibility of a compact layout in the turbine room, recent practice seems to depart from that just indicated, i. e., placing boiler and engine room side by side, divided by

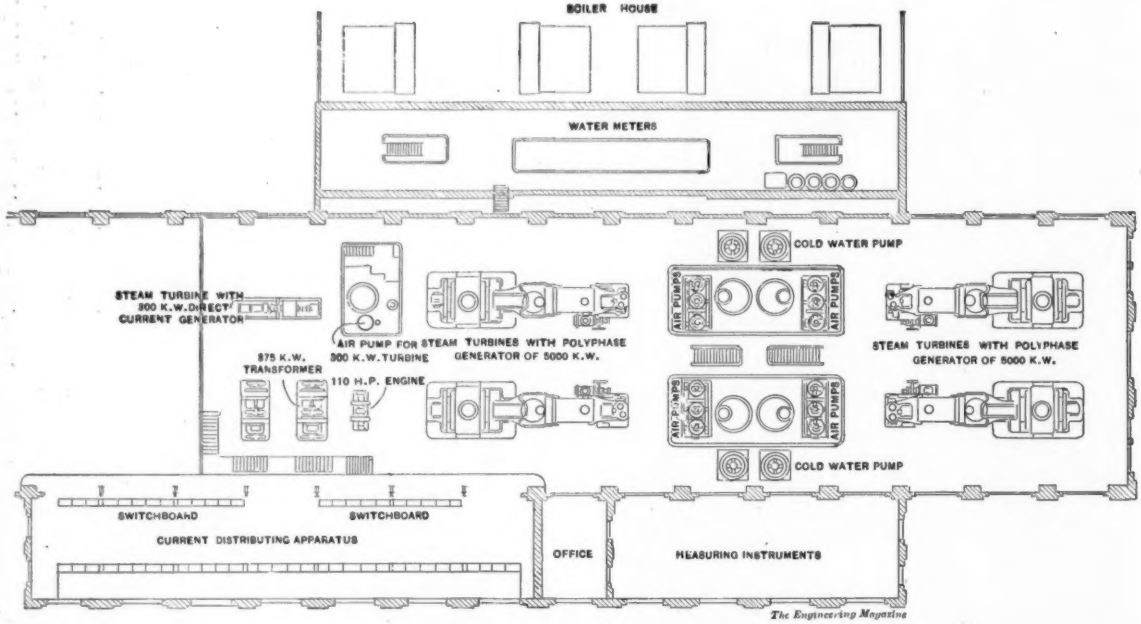


FIG. 8. PLAN OF THE ST. QUEN PLANT, PARIS.

a single wall. For example, the Carville plant, Figure 9, below, supplying power for the North Eastern Railway in England, also the new Public Service Corporation plant still under course of construction in New Jersey; in both of these cases the boiler houses lie at right angles to the turbine rooms, thus providing four or more rows of boilers, depending upon the number of prime movers and the length of the turbine room. A similar layout will also be found in the St. Quen or St. Denis plant still under course of design of Paris, which will furnish the power for the city railway. This plant will be equipped with four main units of 5,000-kilowatt Brown Boveri-Parsons steam turbines, which will be supplied with steam from twenty boilers placed in four rows at right angles to the generating

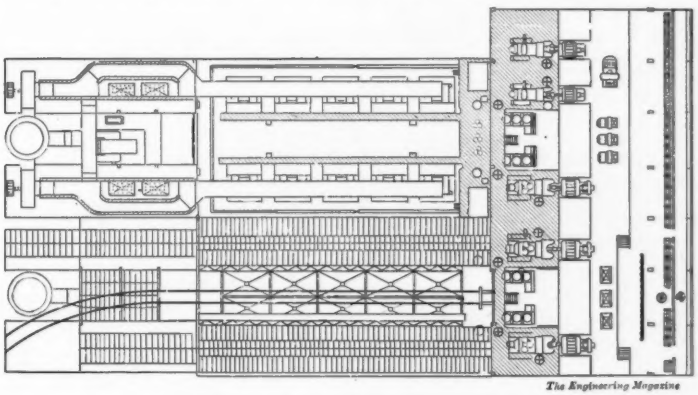


FIG. 9. CARVILLE POWER STATION, NEWCASTLE, ENGLAND.

room. It may therefore be assumed that the compactness of the turbine room may create a revolution in the design of the boiler house, introducing a more general use of the vertical type of boiler. To avoid the adoption of this type of boiler, a two- or three-story boiler house may be constructed, but there are countries (such as France) where the building laws prohibit the use of more than one story of boilers. French engineers have therefore adopted a B. & W. marine-type water-tube boiler, which on account of its small floor space is well adapted for use in conjunction with steam turbines; but by allowing two exceedingly wide passages of some 30 feet between the rows of boilers, there are only 4 square feet of heating surface per square foot of boiler-house floor, compared to the Chelsea plant (Figure 11 and 12) supplying power for the electrification of the

FIG. 10. POWER HOUSE OF THE METROPOLITAN STREET RAILWAY SYSTEM, 96TH STREET AND EAST RIVER, N. Y.

By courtesy of the Mead-Morrison Co., N. Y. Their coal-handling installation is seen on the right.

London Underground Railway; this consists of two tiers of B & W stationary boilers with Green economizers, in which 1 square foot of floor space (on each floor) gives 4.3 square feet of heating surface.

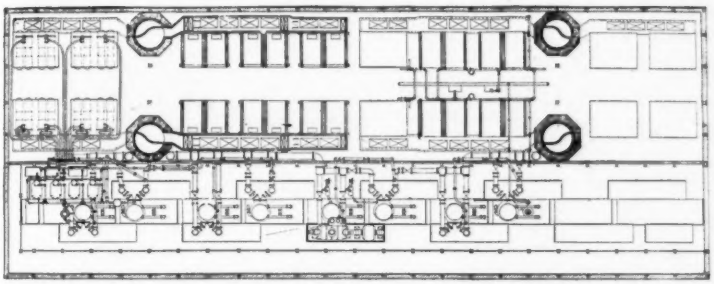


FIG. 11. CHELSEA STEAM-TURBINE PLANT, LONDON. PLAN.

A still greater result—and probably one of the best in this direction—is that of the design of the New York Rapid Transit power house by Mr. John Van Vleck. The result of 7.5 square feet heating surface per 1 foot floor space is due to locating the economizers on the second floor, as will be seen in the accompanying illustration, Figures

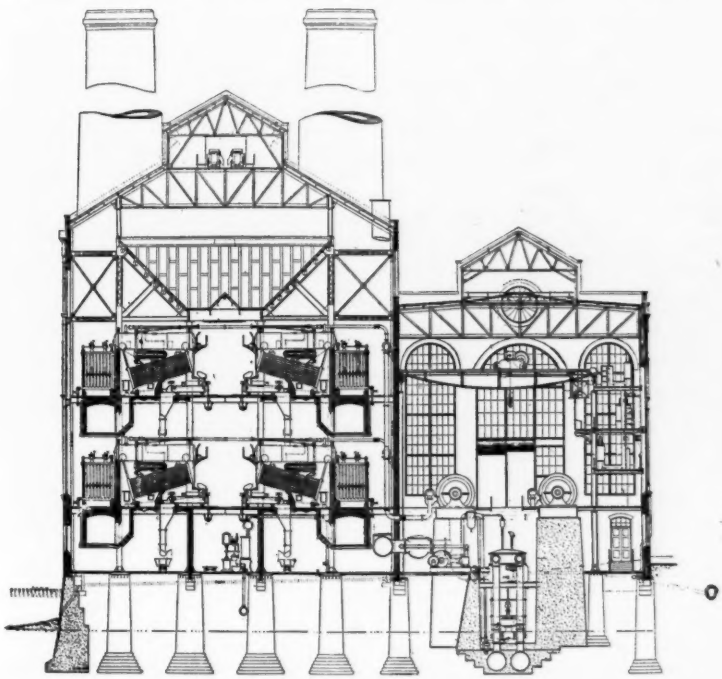


FIG. 12. CHELSEA STEAM-TURBINE PLANT, LONDON.

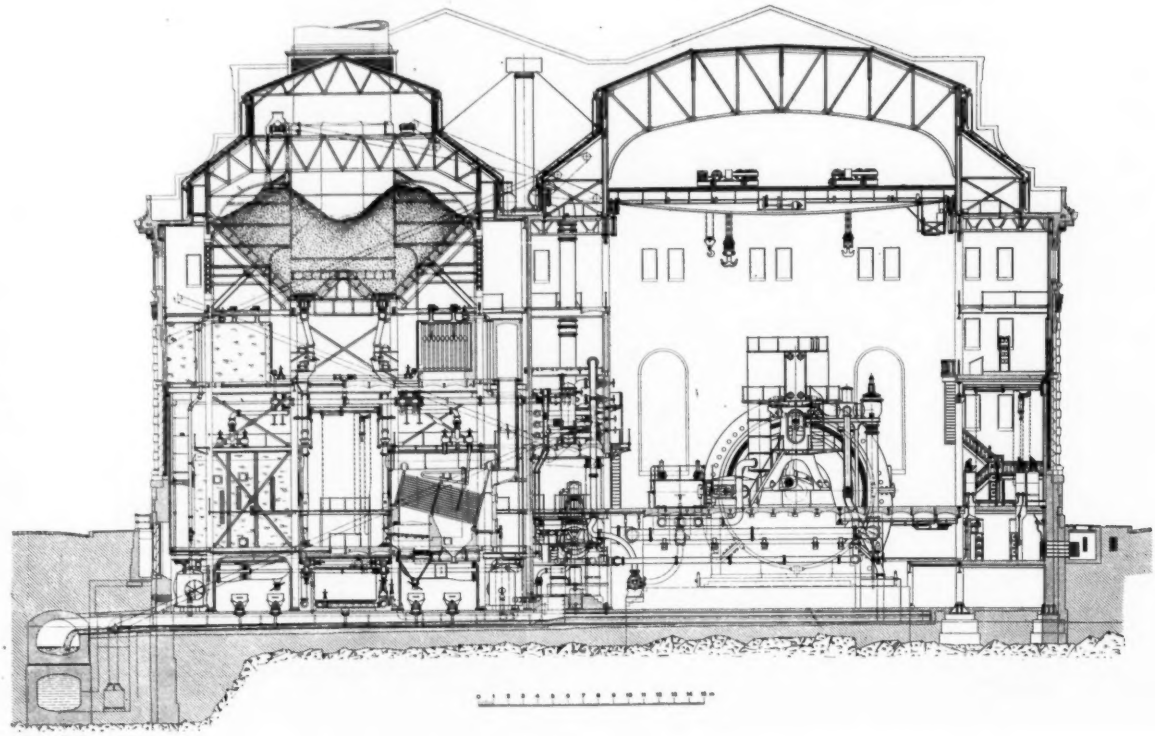


FIG. 13. SECTION OF THE "SUBWAY" POWER-HOUSE OF THE INTERBOROUGH CO., NEW YORK.

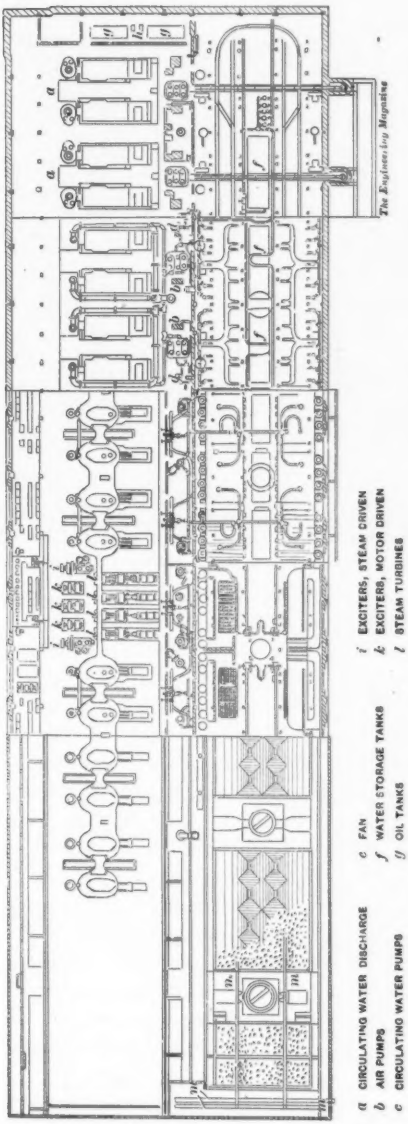


FIG. 14. PLAN OF THE INTERBOROUGH COMPANY'S SUBWAY POWER PLANT, 59TH ST., NEW YORK.

13 and 14; furthermore, the six smoke-stacks of this plant are carried on steel columns above the boiler room. The construction of many brick-lined steel flues necessary to carry the smoke to the stacks is exceedingly expensive.

It may be of interest to give here the weights of steel required for the columns, floor beams, etc., in two prominent recently constructed power plants—the Chelsea plant, of London, and the Interborough Rapid Transit plant of New York City. Both of these boiler plants are constructed in two tiers, over which are placed the coal bunkers, which are of practically the same capacity, about 15,000-tons each. In the former, on account of the adoption of the steam turbine as the prime mover, the generator room is both lower and narrower than the boiler room, although of the same length,

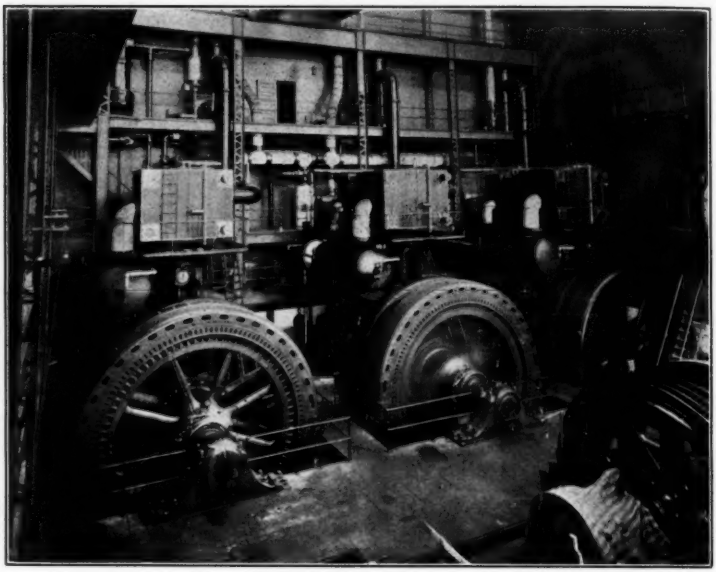


FIG. 15. INTERIOR OF THE POWER STATION, CITIZENS' HEAT, LIGHT, AND POWER CO., ROCHESTER, N. Y.

Three vertical cross-compound Corliss engines, direct-connected to 1,360-kilowatt alternators. Designed and built by Southwark Foundry & Machine Co., Phila.

and the total area covered by the entire plant is about 77,550 square feet; in the latter plant, where reciprocating engines are installed, the engine room is wider than the boiler house and the same height, the entire plant covering an area of about 138,600 square feet. The former is designed for an ultimate capacity of ten 5,500 kilowatt turbines and one 2,700-kilowatts, making a normal total capacity of 57,700 kilowatts. The New York plant is constructed to accommodate twelve units similar to the nine already installed, which could give a normal total capacity of 72,000 kilowatts. The total amount of steel in the Chelsea plant, 6,000 tons, gives .077 tons per square foot of power-plant area, while the New York Subway plant with 12,300 tons of steel gives .088 tons per square foot, about 14 per cent. more than the former. Comparing them according to the kilowatt output, the former has 0.105 tons per kilowatt and the latter 0.170 tons per kilowatt, an increase of 67 per cent. It must be borne in mind that the six smoke-stacks, weighing 1,175 tons each, are supported by steel columns, which at the same time support the boiler-room floor, etc., but it will be seen that the additional steel for this purpose is practi-

cally negligible. The cost of the steel in the New York plant is about 12 per cent. of the total cost of construction.

In regard to steel construction, I should mention that the art and science of this branch of engineering consists of covering an area with the smallest amount of steel which will support safely the given load.

On the continent of Europe, power plants are usually constructed of one-story and the floor-space efficiency is not of vital importance on account of the cost of land. An exception to this system is that of the Berlin Underground and Elevated Railroad power station, which is very similar to common American practice, particularly to the Duane Street power house of the New York Edison Company, in which the boilers are located directly above the engine room. A typical Continental power plant is shown in Figures 16 and 18, which represent one of the Vienna twin municipal plants,* designed by the Schuckert Company, who with the Berlin Allgemeine Elektricitäts Gesellschaft and the Siemens Companies have built many similar plants.

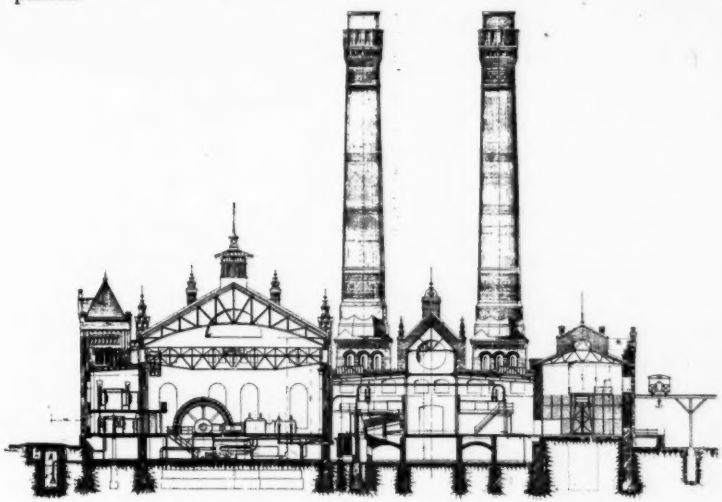


FIG. 16. CROSS-SECTION OF RAILWAY POWER PLANT, VIENNA.

It often happens that plants must be installed in a muddy locality, when it becomes necessary not only to give the engines and boilers solid foundations, but the foundation of the entire plant must be of solid construction, which may be accomplished by driving piles and

* Franz Koester—*Electrical Review*, Jan. 9, 1904.

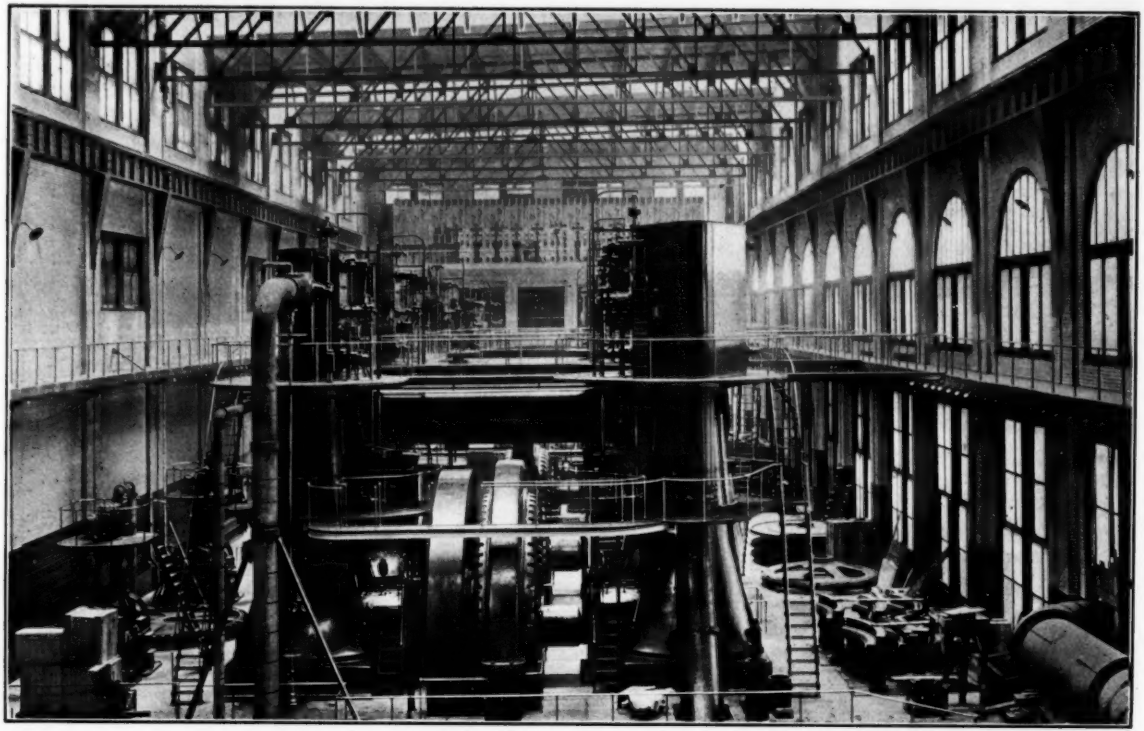


FIG. 17. AN EXAMPLE OF A MODERN AMERICAN CENTRAL STATION INTERIOR.

The plant of the Union Light and Traction Co., St. Louis, Mo. Three 3,500-horse-power and two 2,500-horse-power Allis-Chalmers vertical cross-compound engines.

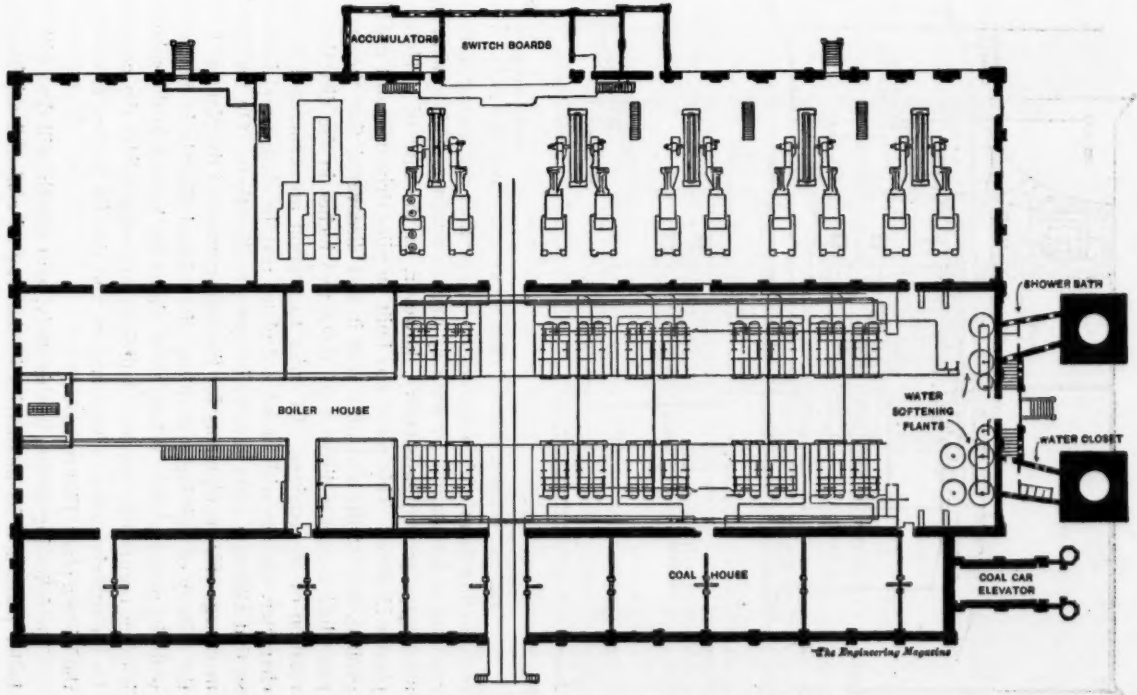


FIG. 18. RAILWAY PLANT OF THE VIENNA MUNICIPAL INSTALLATION.

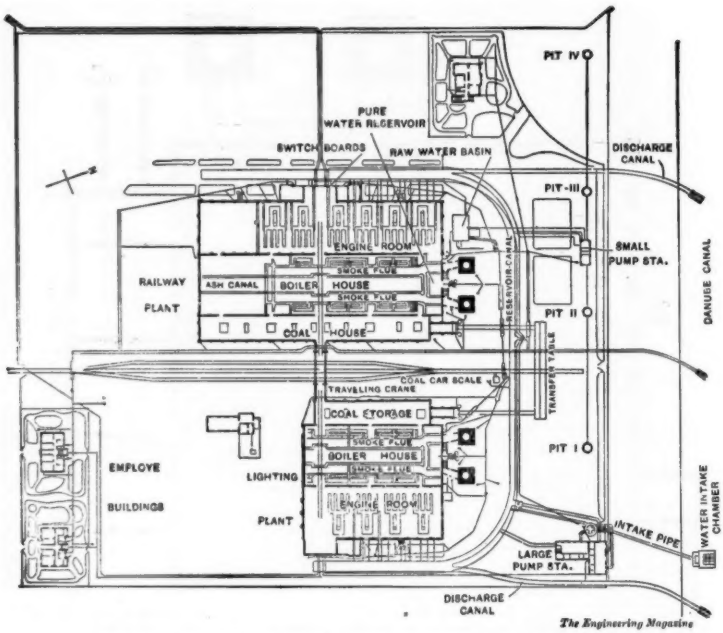


FIG. 19. GENERAL PLAN OF TWIN MUNICIPAL PLANT, VIENNA.

re-enforcing them with iron rods or beams, thus preventing ultimate cracking of foundations or walls by uneven settling. This system has not always proven satisfactory, however, as the case of a Holland plant will show. This plant was built on piles driven in soft muddy ground, and at the end of a year it was discovered that the entire plant had moved a distance of about two inches in the direction of rotation of the engines. In order to prevent an occurrence of this character, engines with broad bed plates may be chosen and installed so that alternate units revolve in opposite directions. On the Continent large office equipments for the management of the plant and also the railway or lighting system are often found directly in connection with the power plant. Where these plants are located in the suburbs, it often occurs that separate buildings are supplied by the company for the superintendents and operators, and also for a store, as example the Vienna plant, Figure 19.

The following section of this study, next month, will deal with the boiler plant and its auxiliaries in the way of coal and ash-handling machinery, stokers, mechanical draft appliances, etc.

COST KEEPING IN GENERAL CONSTRUCTION AND CONTRACT WORK.

By A. W. Buel.

III. SOME ELEMENTS OF AN IMPROVED SYSTEM FOR EXTENSIVE WORKS.

Mr. Buel concludes, in this issue, the discussion of cost-keeping methods in contract work which he began in our March number and continued in May. It has been with him largely a labor of love—carried on amid the heavy burdens of his professional work because of his keen interest in the subject and his strong desire to see it advanced to a plane of sounder method and more scientific study. We are glad to say that the great purpose of awakening intelligent interest in the matter has been accomplished, and we shall be able to follow Mr. Buel's papers with others by engineering contractors who are in daily contact with these problems of cost determination and analysis. A very important contribution to the subject by one of the best known engineers in the country will appear in THE ENGINEERING MAGAZINE for September.—THE EDITORS.

THE difficulties quite generally responsible for failures to secure satisfactory results from cost keeping on general contract work may be classified under three heads.

1. Lack of initiative talent in the design, adaptation, and correction of the methods.

2. Lack of the requisite intelligence and force to make the records complete and keep them posted up to date.

3. Difficulty in collecting, analyzing, and segregating the great mass and complication of figures encountered on large works.

The first of these conditions can be met by the employment of consulting experts, either temporarily for the inauguration of a system, or continuously for advice as difficulties arise and modifications are required to meet new conditions. On very large works the employment of auditors or chief accountants of sufficient calibre to devise good systems and keep them up is justified and advisable.

The second difficulty could not exist for any length of time in a well managed organization, and where it does exist, it is a discredit. It is rather remarkable, not that it is so often encountered, but that a good many contractors admit it. In many, if not the majority, of such cases, the real difficulty is due more to the lack of initiative, direction, and encouragement on the part of the management than to any deficiency on the part of the employees, either in intelligence or force. Where incapacity of the employees actually exists, it is due to false

economy and the remedy is to employ better men and pay them what they are worth.

The larger and more complicated the work, the higher should be the pay of the accountants and time keepers in order to secure and hold competent men. But on the other hand, the larger and more complicated works can well afford to carry the burden, and the percentage of expense for auditing and accounting should not be greater than on small works. In reality it should be less, were it not for the fact that on large and varied works cost keeping has additional functions to perform that are not required on small undertakings, where all the men and operations are practically under the eye of the manager. These additional functions consist in segregating the costs in more ways—giving a more complete analysis—than is generally necessary on the smaller works, and this somewhat increases the amount of work. As has been pointed out in a previous article of this series,* there will generally be found on any contract job, large or small, men of sufficient intelligence and reliability to co-operate in keeping costs under proper direction, provided the system is properly adapted to the conditions.

It remains to consider the third difficulty—that of the large amount of arithmetical and clerical work involved in distributing cost records and reducing the results to useful forms. This does not apply to contract work where the number of men employed is not large and where the operations are simple. For such cases, the system used by the Terry and Tench Company, and described in the May issue of THE ENGINEERING MAGAZINE, offers a very satisfactory solution with the minimum amount of clerical work, and one that can be easily adapted to the requirements of any contracting business where the operations are not of very great magnitude nor very complex.

There is, however, very little doubt that on very large works, the mere contemplation of the number of figures and amount of tabulating and accounting involved in keeping costs with full distributions has, in many cases, deterred the management from attempting it; or if they have made the attempt, the results have been so long delayed as to lose most of their value. It is the main purpose of the present article to show how such large masses of accounts, figures, and computations can be handled by a relatively small force and at such reasonable expense as to be entirely justifiable, without in any way curtailing or prejudicing the results. The following illustrations do not by any means form a complete system, nor even connected parts of a

* THE ENGINEERING MAGAZINE, March, 1905, page 974.

system, but are presented simply as elementary units which may be made use of, in whole or in part, in devising a system for, let us assume, a large contract for railroad construction.

To begin with, a set of rules or regulations will be drawn up and issued to all employees concerned, concisely stating how each and every transaction is to be entered in the books or forms provided, and how and when the returns are to be made to the general office or auditor. It will be a great assistance if a complete example of each form is filled out to accompany the rules or instructions.

Embodied in these rules and regulations of the auditing department, and composing a very important part thereof, should be an analytical list of all accounts, with distribution numbers assigned to each. These should be printed in pamphlet form, 6 inches by 9 inches, and issued to all superintendents, accountants, and time keepers. Where foremen are charged with reporting the distribution of labor, they should be supplied with a copy. The following arrangement and schedule,—taken from the System in use by MacArthur Brothers Company, was devised by the Everett Audit Company.

GENERAL EXPENSE.—"The general expense of the company is divided into four departments, and designated by these prefixes:—

OFFICES.	DEPARTMENTS.	INITIAL.
Chicago	Executive	CE
"	Maintenance	CM
"	Accounting	CA
Contract	Operating	(Special List)

"The Executive Department includes the salaries of the general officers such as the president, vice-president, secretary, treasurer, assistant secretary, and any clerks or stenographers directly connected with the work of this department; the office expenses pertaining to this department; also all the general expense of the company that is not chargeable to a contract office, or some other general department.

"The Maintenance Department includes the salaries and expenses of the civil engineers, purchasing agent, master mechanics in Chicago office; the office expense pertaining to this department; also the general expense of the employees of this department, such as traveling expense, etc. Also, as a sub-department, the expense, etc., of the McCook shops for the general repair and storage of plant equipment.

"The Accounting Department includes the salaries of the auditor, accountants, clerks and stenographers in Chicago office required in making or keeping the general records of the company; the office expense pertaining to this department; also the general expense of the employees of this department, such as traveling expense, etc.

"Each contract office will be given a special 'prefix' consisting of two 'initials' or letters. (See list.) This department includes the salaries of the superintendents, assistant superintendents, engineers, clerks, and stenographers engaged on the contract, and the record of each contract is to be kept as a separate and distinct account, so that each contract report shall show the actual gain or loss for the same; the office expense in connection therewith; also any sundry general expense pertaining to and directly connected with that contract."

VOUCHER DISTRIBUTION.

CONTRACT OFFICES.

Initial Prefix.	Contract No.	Name of Contract.
CL	1	Clinton
CL	2	Clinton
TH	3	Thebes
FR	4	Froemsdorf
FO	5	Frisco
HM	6	Hawkins Mines
BL	7	Pine Bluff
BD	8	Bloomfield
ZE	9	Zeta
NW	10	St. Louis-Northwest'n
KC	11	Kansas City-St. Joe
NF	12	Newton Falls
NV	13	Pinckneyville
AD	14	Ada
HO	15	Hillsboro
SR	16	Sand Ridge
CV	17	Curve—Atoka
SN	18	Sutton
CC	18	Sutton—Coal & Coke
ZA	19	Zanesville
MA	20	Pere Marquette
AL	21	Alliance
SH	22	Power House—St. Louis
YA	23	Yarborough
WC	24	Webster City
EL	25	Elkhart
CU	26	Curwensville
CF	27	Cuyahoga Falls
CD	28	Cumberland
LD	29	Litchfield

GENERAL EXPENSES.

Expense Items	Distribution No.
Salaries.	
Superintendent	1
Assistant Superintendent	2
Engineers	3
Clerks—Timekeepers	6
Stenographers	7
	8
	9
Office Expenses.	
Printing—Stationery	10
Office Supplies	11
Postage	12
Telephone	13
Telegrams	14
Rent	15
Light—Heat	16
Sundries—Office Expenses	17
	18
	19
General.	
Traveling Expenses	20
Hotel—Meals—Overtime	21
Livery	22
Advertising	23
Insurance	24
Discount—Exchange	25
Freight—Express (Sundry)	26
Repairs—Office, etc.	27
Sundries (General)	28
Legal Expenses	29
License Taxes	30
Charity	31

EXPENSE UNITS.

"The expense or cost of all labor, supplies, etc., connected with the contract is classified by the units 0 to 9 as follows:

0—ACCOUNT. The account or charge number to designate each department. Always to be used in transferring balance from one department into another.

1—FOREMAN. Wages of foreman.

2—LABOR. Wages of laborers.

3—TEAMS. Cost of teams, a monthly transfer charge. The

amount or rate per horse is arrived at by taking the total cost of Stable Department No. 40 and dividing it proportionately on basis of 'horse hours' worked. Wages of teamsters in each department where work is performed.

4—SUNDRIES. Sundry items of expense that are not specially covered by any of the other units.

5—REPAIRS. The cost of all the labor and material used in making repairs in the departments. This will consist, principally, of the monthly charges—transfers from the 'Repair Shop' Account No. 50.

6—SUPPLIES. All supplies used in the department. Items of supplies that are solely used in one department, and will be entirely used during the month in which they are received, may be charged direct to this unit in the proper department; but if the quantity is to be divided into two or more departments, or is not all used in one month, it should be charged to Supplies Account No. 370, and then have the charges brought over from the daily summary of the requisitions for the article as it is delivered and used.

7—FUEL-POWDER. Cost of fuel, powder, or feed, according to the item and department in which it is used. The cost of the feed for the stable is charged to this unit No. 47.

The cost of explosives—dynamite, powder, fuse, and caps—for excavating, etc., as No. 257, 407, 427, etc. The cost of coal, etc., for fuel for the several departments, as No. 57, 67, 77, etc.

These charges will come from supplies account No. 370 as reported on requisitions.

8—MATERIAL. This unit is strictly for 'Construction Material' used on the contract, and for which the company will receive payment through the engineer's estimates, and must not be confused with ordinary 'Repair Supplies,' which are expense items. In case of emergency, where it becomes absolutely necessary to use any construction material for repair work (an expense), the item must be issued on a requisition, and transferred or charged to the proper repair item in the proper department, giving credit to Material Account for the actual cost.

All bills for construction material must pass through the 'Material Account,' and be charged out only when used or put in place, being credited to No. 380.

9—RESERVE. This unit is for the monthly charge to the several departments, for the monthly proportion of plant rental, plant depreciation, development, and the general expense of the Chicago office. The reserve is only divided to departments Nos. 49 to 209, and Nos. 359 and 369.

DISTRIBUTION SCHEDULE.

Department Accounts.	0 Acct. No.	1 Foreman.	2 Labor.	3 Team.	4 Sundries.	5 Repairs.	6 Supplies.	7 Fuel Powder.	8 Material.	9 Reserve.
OPERATING.										
Stables (horses)	40	41	42	43	44	45	46	47	...	49
Repair Shops—Tools	50	51	52	53	54	55	56	57	...	59
Water Department	60	61	62	63	64	65	66	67	...	69
Power	70	71	72	73	74	75	76	77	...	79
Electric Light	80	81	82	83	84	85	86	87	...	89
Boats	90	91	92	93	94	95	96	97	...	99
Locomotives	100	101	102	103	104	105	106	107	...	109
Cars	110	111	112	113	114	115	116	...	...	119
Track	120	121	122	123	124	125	126	...	...	129
Excavators	130	131	132	133	134	135	136	137	...	139
Pile Drivers	140	141	142	143	144	145	146	147	...	149
Drills—Steam, Air	150	151	152	153	154	155	156	...	...	159
Machinery—Derricks	160	161	162	163	164	165	166	167	...	169
Plows—Implements	170	171	172	173	174	175	176	...	...	179
Wagons—Scrapers	180	181	182	183	184	185	186	...	...	189
Pit Tools (Picks, etc.)	190	191	192	193	194	195	196	...	...	199
Contract—General	200	201	202	203	204	205	206	207	...	209
Blasting	250	251	252	253	254	255	256	257	...	...
Loading—Mucking	260	261	262	263	264	265	266	...	...	...
Hauling	270	271	272	273	274	275	276	...	...	...
Dump	280	281	282	283	284	285	286	...	...	...
Trestle—Timbering	290	291	292	293	294	295	296	...	...	...
Commissary	350	351	352	353	354	355	356	357	...	359
Hotel—Camp	360	361	362	363	364	365	366	367	...	369
Supplies	370	...	372	373	374	...	...	...	...	...
Construction Material	380	...	382	383	384	...	...	...	...	...
GRADING.										
Clearing	400	401	402	403	404	405	406	407	...	...
Close Cutting	410	411	412	413	414	415	416	...	...	...
Grubbing	420	421	422	423	424	425	426	427	...	...
Earth Excavating	430	431	432	433	434	435	436	437	...	...
Hard Pan	440	441	442	443	444	445	446	447	...	...
Cement Gravel	450	451	452	453	454	455	456	457	...	...
Solid Rock	460	461	462	463	464	465	466	467	...	...
Loose Rock	470	471	472	473	474	475	476	477	...	...
CULVERT—TRESTLE.										
Iron Pipe	520	521	522	523	524	525	526	...	528	...
Vitrified Pipe	530	531	532	533	534	535	536	...	538	...
Timber	540	541	542	543	544	545	546	...	548	...
Piles—Trestles	550	551	552	553	554	555	556	...	558	...

These schedules are accompanied by concise directions as to what items and details pertain to each distribution number and how the accounts are to be posted and reported. The "Reserve Depreciation" is arbitrarily fixed for each item of plant, and varies from 0.5 per cent. per month for tools and real estate to 4.0 per cent. for marine equipment. These percentages have been fixed with good judgment, except

DISTRIBUTION SCHEDULE.

Department Accounts.	0 Acct. No.	1 Foreman.	2 Labor.	3 Team.	4 Sundries.	5 Repairs.	6 Supplies.	7 Fuel Powder.	8 Material.	9 Reserve.
FOUNDATION.										
Wet Earth Excavating...	580	581	582	583	584	585	586	...	...	...
Dry " " ...	590	591	592	593	594	595	596	...	...	...
Wet Rock " ...	600	601	602	603	604	605	606	607	...	...
Dry " " ...	610	611	612	613	614	615	616	617	...	...
MASONRY.										
Bridge, 1st Class.	640	641	642	643	644	...	646	...	648	...
" 2nd "	650	651	652	653	654	...	656	...	658	...
Masonry, 3rd "	660	661	662	663	664	...	666	...	668	...
" (Mortar) 4th "	670	671	672	673	674	...	676	...	678	...
" (Dry) 4th "	680	681	682	683	684	...	686	...	688	...
" (Arch) 1st "	690	691	692	693	694	...	696	...	698	...
" (") 2nd "	700	701	702	703	704	...	706	...	708	...
Paving	710	711	712	713	714	...	716	...	718	...
Rip Rap	720	721	722	723	724	...	726	...	728	...
Concrete	730	731	732	733	734	...	736	...	738	...
Rubble—Cement	740	741	742	743	744	...	746	...	748	...
" —Dry	750	751	752	753	754	...	756	...	758	...
Brick	760	761	762	763	764	...	766	...	768	...
TUNNEL.										
Excavating Total	800	801	802	803	804	805	806	807	808	809
Masonry, Sidewall, 1st Cl.	810	811	812	813	814	...	816	...	818	...
Masonry, Sidewall, 2nd Cl.	820	821	822	823	824	...	826	...	828	...
Masonry, Sidewall, 3rd Cl.	830	831	832	833	834	...	836	...	838	...
Masonry, Sidewall, 4th Cl.	840	841	842	843	844	...	846	...	848	...
" Arch 1st, "	850	851	852	853	854	...	856	...	858	...
" " 2nd, "	860	861	862	863	864	...	866	...	868	...
" Brick—Sidewall.	870	871	872	873	874	...	876	...	878	...
" " Arch ...	880	881	882	883	884	...	886	...	888	...
" Concrete — Sidewall	890	891	892	893	894	...	896	...	898	...
" Concrete—Arch.	900	901	902	903	904	...	906	...	908	...
Dry Packing	910	911	912	913	914	...	916	...	918	...
Timber Lining	920	921	922	923	924	...	926	...	928	...
Iron Work	930	931	932	933	934	...	936	...	938	...
McCOOK SHOPS.										
Blacksmith	950	951	952	953	954	955	956	957	958	959
Machine	960	961	962	963	964	965	966	967	968	969
Wood	970	971	972	973	974	975	976	977	978	979
Pattern	980	981	982	983	984	985	986	987	988	989
Yard	990	991	992	993	994	995	996	997	998	999

that 0.5 per cent. seems small for picks, shovels, and small tools. A "Reserve Rental" for plant is also charged to each department and contract.

It will be noted that there are nine expense units or sub-divisions of department accounts. Should a larger number be required, they can be provided by giving each department account a number divisible

by 20, beginning with 40; or, as will be better in some cases, even-hundred numbers. The latter arrangement will run most of the distribution numbers into four figures, but with mechanical and electrical accounting machines, this is no disadvantage. It is rather to be preferred, if nine expense units do not give sufficient detail, and for masonry, concrete, and structural work generally, a somewhat greater sub-division appears to be desirable. Some numbers are left blank to provide for special distribution accounts when required.

In organizing the force of time keepers and clerks on a large contract there should be at least one man on each division who has sufficient knowledge of engineering to make measurements and calculate quantities. One of the first duties of these men should be to make a record of the original cross sections, from the center and slope stakes (or by measurements), unless they can be obtained from the engineer. This work should be done before ground is broken at the points where grading is to be commenced, and should always be kept up ahead of the graders.

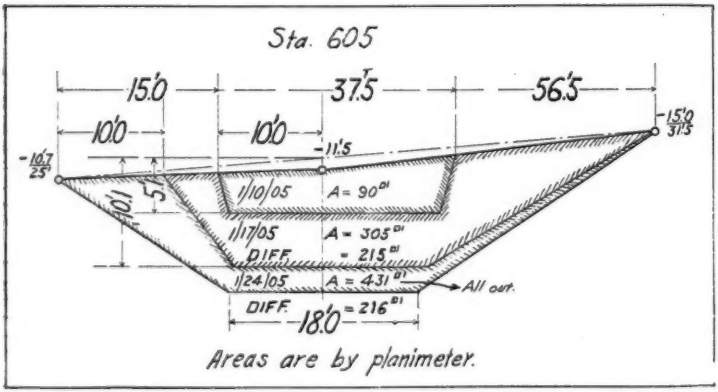


FIG. I. EXAMPLE OF PROGRESS CROSS SECTION, INDICATING HOW MEASUREMENTS MAY BE TAKEN BY APPROXIMATE METHOD.

At the end of each month, or at the close of each pay-roll period, or at any time desired, two men can make approximate measurements from which quantities can be computed with sufficient accuracy for the purpose of determining unit costs or for checking engineers' estimates. This work can be done with great rapidity if properly laid out and arranged. The cross sections should be plotted on cross-section paper, and the progress notes recorded on the same. The areas

can then be read off by planimeter, and, from these, one setting of a slide rule gives the cubic yards.

On blue prints of the working drawings of masonry and other structures, the same men should note the actual elevations of foundations and draw lines denoting the progress of the work at corresponding dates.

All the quantities should then be entered on an estimate sheet, in columns corresponding to their respective department-account numbers, and on the line assigned to the section, station, structure, or foreman to which they belong. The summation of the vertical columns gives the total of each kind, and the arrangement is such that the quantities belonging to any part of the work or to any foreman can be readily taken off. The costs, divided by these quantities, give the unit costs sought.

The time keepers will list and number all employees, assigning to each division, department, or foreman's gang a series of consecutive numbers. While consecutive numbers by divisions cannot be maintained unbroken, on account of unavoidable transfers, it will be found to greatly facilitate the work of summarizing results to have the majority of the workmen in each group numbered in one series. The time may be recorded in short-leaf time books or in special books, in which the name (correctly spelled), as well as the number of each man is distinctly written. It is not probable that the distribution of time can be successfully taken by the time keepers, unless they should record it at the dictation of the foreman. For this reason, foremen should be furnished with sheets for daily labor distribution reports, see Figure 2. On these sheets the foreman will fill in the account numbers at the head of each column, according to the distribution schedule, and the time of each man, including his own, on each account. He will also fill in the total time of each man and in the column of "Remarks" the reason for short time, giving the number or name of other foremen to or from whom transfers were made. Any unusual or accidental incidents which affect the progress or cost of the work should also be noted under "Remarks."

The Daily Labor Distribution Report sheets should be returned to the office at the close of each working day, where they will be transcribed to the punched record cards of the Hollerith electrical tabulating machine. Figure 3 is the fac-simile of such a card designed for analyzing a shop pay roll, and used by the bridge and construction department of the Pennsylvania Steel Company. With a few changes, such as inserting letters in four columns for the designation of con-

Form 1 6-20-05, - 10 M.

THE A.B.C. CONTRACTING CO.

FOREMAN'S DAILY LABOR DISTRIBUTION REPORT.

Contract (Name or Number) C. D. June 20, 1905 Day (or) ~~Night~~ Shift

Section No. (Station or Structure) Foreman John O'Brien, - 600

Men's Numbers	592	582	593	583	581	571	731	732	733	162		Total Hours	Remarks
600					2	2	6					10	Foreman
601													
602													
603	5											5	Transferred to E 581
604		10										10	
605			4									4	Trans. from Emp 74
606			10									10	
607								10				10	
608								10				10	
609			5	5								10	
610		10										10	
611	10											10	
612	8							2				10	
613	10											10	
614		8						2				10	
615								10				10	
616								5				5	Knocked off sick
617									10			10	
618									10			10	
619												—	
620								10				10	
621												—	
622								10				10	
623	5	5										10	
624								5		5		10	
625										10		10	
626													
627													
628													
629													
630													
721									10			10	
519									10			10	

FIG. 2. SHEET FOR LABOR DISTRIBUTION REPORT.

tract or department, another column for the designation of the foreman's number, the addition of the letters "H" and "B" to designate heading or bench in tunneling, the omission of columns for "Number of Pieces" and "Class" and the substitution of "Force Account" for "Extra"—we would have a suitable card. The cards, however, will vary more or less as the character of the work changes.

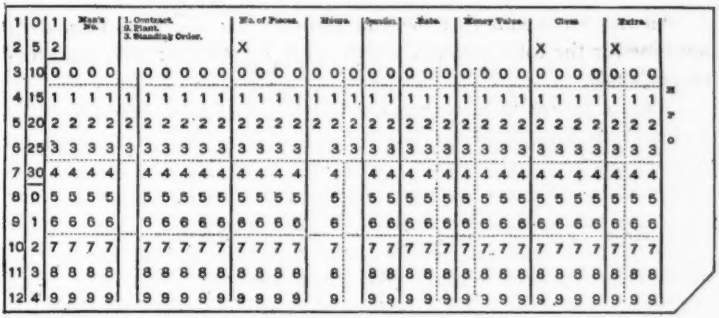


FIG. 3. EXAMPLE OF CARD DESIGNED FOR ANALYZING A SHOP PAY-ROLL BY AID OF THE TABULATING MACHINE.

The date or day columns are punched on a "gang punch" which punches all the holes required in ten or fifteen cards at one operation. The man's number, account number, foreman's number, hours and rate are then punched on a key punch. A separate card is punched for each man and for each account number on which he has worked. All of this work is rapidly performed by boys who receive from $3.00 to $5.00 per week.

When the rate and hours have been punched in the cards, they may be put into an automatic sorting machine, which will separate out all cards having the same time (hours) and rate of pay. The amounts are then carried out by tables of wages or computed with the "Bruns-viga" calculating machine, and recorded on the cards with the gang punch or key punch as required. Figure 4 is the fac-simile of a punched card.

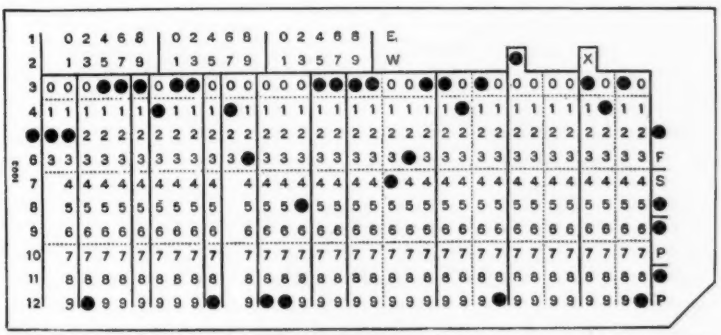


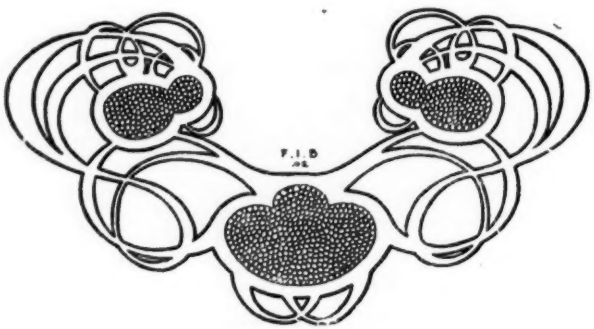
FIG. 4. SHOWING A CARD AS PUNCHED FOR TABULATION AND COST ANALYSIS BY THE HOLLERITH MACHINE.

All the cards can then be run through the electrical tabulating machine for the total amount, which result must check with the time-keeper's roll.

The cards are then segregated by the automatic sorter, first by account numbers, then by foreman's numbers, and, if desired, by account numbers and foreman's numbers, or by job, structure, or station numbers when the latter are included in the record. The tabulator gives the total amount for each lot of cards as sorted. These results are all entered on manifold sheets, and copies are sent to the general manager, to the auditor, and to the superintendent.

For the purpose of carrying out and distributing General Expense, (Accounts 1 to 39 inclusive), and all similar accounts, I have found a Brunsviga calculating machine a very great relief and time saver. It will multiply and divide, pro-rate and compute interest, quickly and accurately. It is simple, and can be operated with less liability to error than any other machine with which I have worked, on account of the facility it affords for checking the work and correcting an error without going back over the entire computation. It will carry a long series of computations and give both the partial and final results. It can also be used for addition and subtraction, but for addition only it is not quite as quick as the adding machine made by the Mechanical Accountant Company.

An up-to-date accounting department of a large company should be supplied with all the best facilities if it is expected to turn out good work economically. These machines both save time of valuable men, and to some extent permit certain parts of the work to be performed by cheaper labor.



A COMBINED BONUS AND PREMIUM SYSTEM.

By Hugo Diemer.

Mr. Diemer's article has the great interest which attaches to every well considered effort to avert labor troubles and stimulate the workman's productivity by the opportunities and rewards of a wisely planned wage system. It has the vital importance also which belongs to the practical record of actual experience. It not only describes a thing worth doing, but explains how to do it.—THE EDITORS.

THE change from hourly or day rate to a merit system of wages is a step which needs to be well planned and well executed. Otherwise the benefits desired may be delayed or not at all realized. This change is being taken or likely to be taken by many establishments; hence interest will attach to the experiences and methods of an engine and boiler works in adopting a combined premium and bonus system. The system in the form into which it has now developed is original in several ways. The method of compensation for successful effort is different from any enumerated in the various tables, charts, or curves prepared and published for comparison of various wage systems.

The company in question is employing at present some eight-hundred men, although in busy seasons they have had as many as two-thousand men at work in the manufacture of slide-valve, four-valve, and Corliss engines, and fire-tube, marine, locomotive, and water-tube boilers.

The establishment has long been recognized as a stronghold of trades unionism. The management has always accorded fullest recognition to trades unions. Something over a year ago the management proposed to the representatives of the machinists' union the introduction of the 50-per-cent. gain-sharing system of the kind which Mr. Taylor has christened the "Towne-Halsey" plan. The union would not accept this system, but after considerable negotiation agreed to the following plan:—The company was to fix what it considered a fair or "standard" time for each operation. For successful accomplishment of the task within this time, each man was to receive an increase of 20 per cent. over his hourly rate. For agreeing to work under the "standard-operation" plan, any man was to receive a 10-per-cent. increase on his hourly rate for all time spent on tasks on

PRODUCER_____

NON-PRODUCER_____

WEEKLY TIME SHEET

FORM D. 610-S-20-00-SU

	SHOP ORDER	QUAN	NAME OF PART	OPERATION	NO. START	NO. FIN	TIME START'D	T	F	S	SU	M	T	W	TOTAL HRS ON O-C	TOTAL OUT O-C	PIECE ALLOW.	CHECK	GAIN	FIGURE	LOSS	LABOR COST	PIECE COST	TOTAL PLAT COST	REMARKS
															H M	H M	H M	H M	H M	H M	H M	$ ¢	$ ¢	$ ¢	
				TOTALS																					TRANSFERRED BY
				TOTAL TIME FOR WEEK																		T	F	S	SU	M	T	W	TOTAL TIME O. K. AND TRANSFERRED TO PAYMASTER'S VOUCHER BY
																	LATE OFF DUTY ABSENT OVERTIME TIME ACCT'AL FOR O. T.											EXTENDED ON COST RECORD BY

FIG. I. WEEKLY TIME SHEET. ORIGINAL IS 15½ BY 9½ INCHES.

which a standard time limit was set, whether the task was accomplished within the time or not, this being called "the 10 per cent. for effort." For "success," 10 per cent. more was added, making the 20 per cent. all-told. Inasmuch as the company was paying a considerable increase for accomplishment of work within the standard times, these standards had to be a great deal lower than the past performance, which made it harder to start the system than the gain-sharing system, in which the standard is usually not lower by a great deal than past records. It was thought that the 10 per cent. for effort would be the entering wedge, however. The standards, in the case of the machine shop, were figured by the general foreman, based on calculations of feeds and such additions as he thought proper for chucking and getting ready. The majority were fixed very close to the best performance of a skilled man under favorable conditions, this being in accord with Mr. Taylor's and Mr. Gantt's principles. After about a year's trial, it was found that the number of men receiving the 20 per cent. for "success" did not approach the company's anticipations. Visits were made by one of the company's officers to shops using the Towne-Halsey system, and a superintendent of one of these shops was engaged to complete the establishment of standards on such operations as were still without the "stint," and to act in an advisory capacity in giving such assistance and advice to men and foreman with regard to methods of doing the work as would result in an increasing number of men accomplishing "success" under the system.

It was decided to abandon the time-keeping system which had been in vogue, under which each man posted his own time, presumably checked by the foreman. The management adopted the time-taker plan, the form of time sheet being shown in Figure 1. The arguments advanced for this method of time keeping were that experienced time keepers could do this work far more quickly than workingmen, and hence the time saved out of workingmen's time would be more than enough to pay the time-takers' wages. An important phase of the question—that of doctoring the time in favor of the workmen—was not dwelt on at length, since the management had great faith in the integrity of all its employees and the argument of economy was in itself sufficient.

As the "time-taker" method of securing data regarding time required to do work may not be familiar to all, it may be well to explain it briefly. A young man of mature years and judgment, and preferably with machine-shop experience, spends his whole time in going

from man to man in the department to which he is assigned, entering on the time sheet for each workman every change of operation. There is a sheet for each workman, and the sheets for any one department are kept in a metal binder, making it easy for the time taker to make entries while standing.

The "Instructions to Time-Takers" given below will explain fully some details of the system. These instructions were mimeographed and a copy given each time taker and also to each foreman:—

INSTRUCTIONS TO TIME-TAKERS.

"1. Do not take up more of workman's time than is actually required to get the necessary information.

"2. If workman is engaged in handling or setting up heavy work in his machine, do not call him away from same. See him at some later time.

"3. The following questions should suffice to secure all information needed for time-taking:

"When did you start this job?

"How many pieces did you finish on the previous job?

"Where is the tag for your present job?

"Name of operation on job engaged on.

"4. Always bear in mind that the starting time on one job is the stopping time of the previous job. Make no allowance for setting up machine unless time for setting up is allowed and authorized by foreman, with general foreman's approval.

"5. In cases where workmen have no tag for job worked on, notify department foreman, and he will provide workman with same.

"6. Instruct workman to hang tag for job on which he is working in some convenient place for you to see same. In passing about, look at both his tag and his work so as to make sure that he has not changed jobs. Familiarize yourself with the work going through the department to which you are assigned, as that is a great aid to accurate time-taking.

"7. The following information must be correctly given on time sheet, viz.: shop-order number, amount of pieces in lot, name of part, name of operation or operations, premium allowance (where specified on tag only), number of pieces started, number of pieces finished, time started, time finished, and allowances if any. Insist on men reporting correctly the number of pieces finished whenever a break in lot occurs. You will make entries after each job in the proper column headed 'Total not on

Standard Operation,' 'Total on Standard Operation,' 'Success,' 'Gain,' 'Failure' and 'Loss.' Enter these items as soon as the available time entries have been made. Do not make any entries in columns headed 'Labor Cost,' 'Premium Cost' and 'Total Flat Cost,' nor in pay-roll department's items at lower right-hand side of sheet.

"8. You can be of some aid to the foreman in your department by informing him in advance that a man is likely to be out of a job at a certain time. It will be well to notify foreman about thirty minutes previous to the time a man will finish the job he is working on. This will give him a chance to look up the man's next job. When men are overrunning standard time you will notify Mr. —— (this being the consultant referred to), by telephone or messenger.

"9. All time for jobs on which there are no tags will be covered by a list of standing orders. You must govern yourself according to this list in charging time. Be sure to specify fully the nature of any such work. When there is any doubt as to what standing-order number to charge this work to, consult head time-taker.

"10. Make no allowance on account of bad or hard castings or on account of break-downs or other unavoidable causes, unless same are verified by foreman. Foreman must give you an allowance ticket covering the actual time lost. Write time allowed in 'Remarks Column' of time sheet, and turn allowance tickets for the day over to head time-taker, in the evening. Had time-taker will have them endorsed by general foreman and then file them.

"11. Familiarize yourself thoroughly with the Conditions and Rulings in Connection with the Standard-Operation Plan."

The "Conditions and Rulings in Connection with Standard Operation Plan" explain the wage system quite fully, with the exception that no mention is made of any allowances for hard castings, nor of the 10 per cent. allowed for effort. In the case of hard castings, the omission was made because it was thought not best to call men's attention needlessly to this possible source of allowances. In the case of the 10 per cent. for effort, mention of this feature was omitted because the company has taken the stand that this allowance is to be made only on such work as has not yet been accomplished in the standard time as fixed, the intention being to do away with it altogether in time. The text of the rulings and conditions governing the system is given in its entirety on the following pages. It will be noted that they are full and explicit, and leave no opportunities for misunderstanding of the system:—

RULINGS AND CONDITIONS GOVERNING WORK UNDER "STANDARD-OPERATION" PLAN.

In order that all employees may be thoroughly familiar with the conditions and rulings in connection with the Standard-Operation Plan, the following outline has been prepared:—

1. THE 20-PER-CENT INCREASE FOR SUCCESS.

"For all jobs successfully completed within the standard time, the company will pay in addition to the regular hourly wages at which a man is employed, an increase of 20 per cent over his regular hourly rate. For instance, a man employed at 20 cents an hour will be paid 24 cents an hour for all work successfully done under standard-operation plan.

2. THE 50-PER-CENT BONUS FOR GAIN.

"For all jobs successfully completed within less than the standard time, the company will pay in addition to the 20-per-cent increase, as explained in section 1, a gain-sharing bonus of 50 per cent of the man's base rate for all time gained. For instance, if a man employed at 20 cents an hour brings out successfully in 10 hours a job on which the standard-operation time is fixed at 12 hours, he receives 50 per cent of the saving, or 20 cents extra pay, in addition to receiving 24 cents an hour for all work successfully done under standard-operation plan. All those that desire to take advantage of the 50-per-cent or gain-sharing feature of the plan can do so by notification to their foreman.

3. QUALITY OF WORK.

"Work must be completed to entire satisfaction of foreman and inspector. Time is counted for good work only. For instance, if a man has ten pieces to do and spoils one, the time is counted as applying on nine pieces finished.

4. EXTRA WORK ON ACCOUNT OF BAD CASTINGS.

"In case a casting shows flaws after machine work is begun, foreman's attention must be called to same at once. If casting is then thrown out, foreman will determine allowance for time spent on same, and will enter allowance on a credit slip, which he gives workman, who will hand credit slip to time taker at his next round. Time taker will enter credit in "Remarks" column of time sheet.

5. EXTRA TIME ON ACCOUNT OF BREAKDOWNS OR OTHER UNAVOIDABLE CAUSES.

"Foreman's attention must be called to such time at once, and he will determine allowance if any, and hand workman credit slip. Workman will hand time taker credit slip at his next round, and time taker will enter credit, if any, same to be verified by foreman. Work-

men are not permitted to work on machinery repairs excepting those regularly engaged on this work.

6. Several Men Working on Same Standard Operation.

"Where standard-time work is of such nature that it requires to be participated in by a group of several men, each man's share of the bonus, if any, will be in proportion to the number of hours he has put in the job.

7. Time Within Which Work Must Be Done.

"Standard times as fixed constitute the limits allowed, and work must be done within these time limits if credit is desired for the bonus for success.

8. Unfinished Work.

"Any man working on a standard-operation job and not finishing same, will be paid bonus, if any, on only the actual number of pieces in the lot on which complete operation has been performed. If operation has been partly completed and the work is finished by someone else, workman starting the job forfeits his bonus, and workman finishing the job will be paid a bonus on same only if job is finished within a reasonable time limit. It will be left to the foreman to determine if this has been done.

9. Difficulties Preventing Success.

"It is the company's desire to take every step possible to remove any obstacles standing in the way of accomplishing any job in the standard time. They wish and expect the men to make money out of the standard-operation plan. They also wish men and foremen to feel free to make suggestions for improvements which may remove any difficulties in the way of making the stints regularly. Suggestions will be acted upon as promptly as conditions will permit.

10. Permanence of Standard Time.

"Standard time once fixed will not be changed excepting on account of changes in design, introduction of new tools, or entirely different methods of doing the work.

Figure 2 is a daily "Notification to Workman." The daily service in connection with notices to workmen of losses or gains over standard-operation time proved advantageous in many ways. It is realized of course that a retrospective investigation after work is finished and hauled away is always unsatisfactory. There are always numerous plausible causes assigned for the over-running of time, if it is seen that other excuses are wanted than that the time is too low. These slips do not constitute the only effort at time reduction. The

NOTIFICATION TO WORKMAN
OF GAINS ON STANDARD OPERATION WORK

FORM B 614 5-22-05 5M.

EMPLOYE NO. DATE

EMPLOYE'S NAME DEPT.

SHOP ORDER NO. OF PIECES FINISHED

NAME OF PART

OPERATION S. O. TIME

ACTUAL TIME ON JOB HRS. MIN.

TIME GAINED HRS. MINS.

NOTICE: WE ARE ALWAYS GLAD TO HAVE OUR MEN MAKE SUGGESTIONS FOR CHANGES IN FIXTURES, APPLIANCES OR TOOLS TO FACILITATE THE WORK. IF AN IDEA OCCURS TO YOU, WRITE IT OUT AND PUT IT IN SUGGESTION BOX. PRIZES ARE OFFERED FOR BEST SUGGESTIONS.

FIG. 2. NOTIFICATION TO WORKMEN OF TIME GAINED.
Original is on pink paper, 6 by 4 in.

NOTIFICATION TO WORKMAN
OF LOSSES ON STANDARD OPERATION WORK

FORM B 613 5-22-05 5M.

EMPLOYE NO. DATE

EMPLOYE'S NAME DEPT.

SHOP ORDER NO. OF PIECES FINISHED

NAME OF PART

OPERATION S. O. TIME

ACTUAL TIME ON JOB HRS. MIN.

TIME LOST HRS. MINS.

NOTICE: WE ARE ALWAYS GLAD TO HAVE OUR MEN MAKE SUGGESTIONS FOR CHANGES IN FIXTURES, APPLIANCES OR TOOLS TO FACILITATE THE WORK. IF AN IDEA OCCURS TO YOU, WRITE IT OUT AND PUT IT IN SUGGESTION BOX. PRIZES ARE OFFERED FOR BEST SUGGESTIONS.

FIG. 2. NOTIFICATION TO WORKMEN OF TIME LOST.
Original is on blue paper, 6 by 4 in. These slips are used as a means of keeping the workman informed, day by day, of his success or failure in reaching "standard-operation" time, and thus avoiding the uncertainty and dissatisfaction so often attendant on after-investigations.

time-taker's telephone or memorandum messages that men are falling behind, which are sent to the engineer in charge of rate fixing, afford the best opportunities for investigation while the work is in progress.

It is only natural that in a strongly unionized shop, where the standard times are often as low as one-third the old time of doing work, the men require to be closely watched, since even after satisfactory demonstration that work can be done properly with certain speeds and feeds, the men will revert back again to light cuts, and slow speeds, and every other resource of delay that they can conjure up. The prime factor in time reduction must of course be the personal

WORKMAN'S EFFICIENCY AND PREMIUM RECORD

EMPLOYE NAME | EMPLOYE NUMBER | DEPT. | RATE

FORM B 618-6-25-05-2M

WEEK ENDING	TOTAL ON 60		SUCCESS		GAIN		FAILURE		LOSS		BONUS		REMARKS
	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	X	X	
TOTAL FOR PERIOD													
TOTAL FOR PERIOD													
TOTAL FOR PERIOD													

FIG. 3. WORKMAN'S EFFICIENCY AND PREMIUM RECORD.
Original is 6 by 4 in., white card, similarly ruled upon the back, as shown in Figure 5.

observation of the work, resulting in proper speeds and feeds being used and in seeing that loose belts, lame machines, etc., are attended to, proper jigs provided, etc. However, the running records of performance under the system form an important phase of the work, not only being the proof of the pudding, but helping materially in attainment of results. Thus the notification slips to workmen, which are given first to general foreman, then to department foreman, and then to men, keep all of these in close touch with the system. The result is that the causes of over-running are traced up and remedies applied, where otherwise no attention would be paid. Another advantage is that the daily receipt by the workman of a "gain" ticket is an incentive

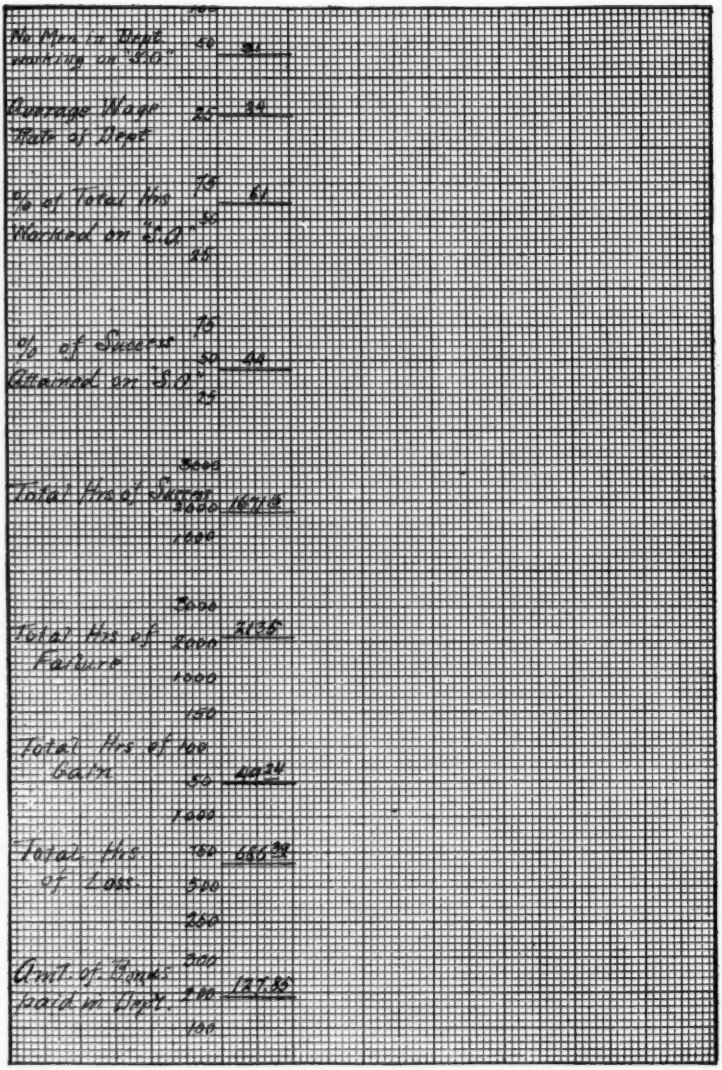

No Men in Dept working on "S.O."
Average Wage Rate of Dept
% of Total Hrs Worked on "S.O."
% of Success Attained on S.O."
Total Hrs of Success
Total Hrs of Failure
Total Hrs of Loss
Amt. of Bonus paid in Sept.

FIG. 4. CHART OF DEPARTMENTAL EFFICIENCY UNDER STANDARD-OPERATION PLAN. Department "C—1—2—4." The record shown is from May 14 to June 11. The original is a large sheet of cross-section paper, a separate sheet for each department.

WORKMAN'S EFFICIENCY AND PREMIUM RECORD

WEEK ENDING	TOTAL ON SO		SUCCESS		GAIN		FAILURE		LOSS		BONUS		REMARKS
	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	X	X	
TOTAL FOR PERIOD													
TOTAL FOR PERIOD													
TOTAL FOR PERIOD													
TOTAL FOR PERIOD													

FIG. 5. WORKMAN'S EFFICIENCY AND PREMIUM RECORD. BACK.

to him to strive for more such tickets. It will be seen that the notification slip contains full information, as well as some words of encouragement to the men.

Figure 3 is the Workman's Individual Efficiency Record. This card is filled at the time of calculating bonus money, (which is paid every four weeks), and the labor of posting on it is negligible, since the clerk figuring the premium pay-roll has to add up the totals for each period for each man at any rate, and instead of doing this on a scratch pad he enters the weekly totals of each man's record on this card. This card will greatly assist in according recognition to the good workmen and in weeding out the bad ones. The card is available in the machine-shop office at all times, which is an advantage, since the weekly time sheets are at certain periods in use by the pay-roll or cost-figuring clerks. The card is much easier to refer to than the weekly time sheets by themselves, as in looking up a workman's record for a considerable period of time, one would have to look through a number of weekly time books, whereas on the card it is neatly condensed for easy reference.

Figure 4 shows how departmental efficiency is charted by periods. The use of straight lines and avoidance of superposing of lines is intentional. These charts must show betterment in each department from period to period.

It will be noted that the endeavor has been to perfect the system

of localizing troubles and of prompt notification regarding them. A diagnosis is made and a prescription furnished for the worst cases as they are brought to light, either by personal observation, by the time-takers' records as shown by "Notification to Workman," or by a message sent from foreman or time takers.

The question may be asked "Could not all this be accomplished by first-class foremanship?" It must be remembered however that high-grade foremen are rare—that they must be educated to higher standards and ideals as well as men. Moreover, the attention to production, and many petty details of foremanship, do not permit of the close attention to time reduction that is required in transitional periods. The systematic study involved in the scheme as outlined is also resulting in greater care and discrimination in hiring labor. It is interesting that the attitude of opposition which characterized the first year's work under the system is gradually passing away as the men become convinced of the fairness and possibility of attainment of the standards, and realize that they are not established by arbitrariness and a desire to oppose the workingmen, but by the absolute necessity of working every machine and every man at high efficiency in order to meet trade competition. Naturally, some errors are bound to be made in not allowing quite sufficient time for setting up, handling, and chucking and other conditions; but the willingness to investigate and correct any errors, coupled with absolute firmness if failure of accomplishment is not due to any errors in rate fixing, are resulting in a steady improvement.

EDITORIAL COMMENT

THE ENGINEERING MAGAZINE, in its issue for September and in the months immediately following, will have the privilege of presenting to the engineering profession and to the world the immensely valuable conclusions of Mr. John F. Wallace's year of study of the Panama Canal problem. The results of his admirable and exhaustive investigations on the Isthmus, directed through a corps of assistants in the field none of whom saw the entire plan and scope of the work—these will be brought together in their proper and intended relation by Mr. Wallace himself, and the deductions established by the same genius that organised and directed the preliminaries. Thus the full import of the knowledge gained for the United States during the first epoch of organized and able engineering direction, will be saved for present use and future guidance. Such information will be of the utmost value in assisting those who are interested in arriving at an accurate understanding of the canal problem, and of the methods to be followed in planning and constructing the great waterway.

Mr. Wallace's discussion, which was originally undertaken for THE ENGINEERING MAGAZINE with the approval of the Washington Administration as a very general statement of the physical aspects of the Canal problem, has thus broadened in scope and risen in dignity, and will appear as the original full synopsis of Mr. Wallace's professional study during his connection with the undertaking. In that record will be found his full justification—if any be needed—before his fellow engineers and the country at large. He will outline briefly the history of the project, the various plans and methods suggested for its execution, the field organisation and operations, the various factors entering into the problems of administration and control, and the engineering and technical features of the plan and construction. He holds steadfastly to the conviction that "at some time, in some way, and at some cost, the original idea will finally be realized," but he is not blind to "the price which is yet to be paid in lives, reputations, and money." He proposes to consider the subject "from the standpoint of a disinterested and unprejudiced investigator, without fear or favor of those who may be selfishly interested politically, financially, or otherwise, eliminating all motives of self interest." No one who knows Mr. Wallace will have the slightest doubt of his holding steadily to this ideal; no one who knows anything of the problem will fail to realise the intense interest and the supreme value of such a contribution to its literature. We are glad to have the honor of presenting it to the profession, and to all who are or may be concerned with the carrying out of the work.

In short, THE ENGINEERING MAGAZINE holds consistently that the Isthmian Canal proposition is to be solved only by close adherence to the logic of facts. As that logic pointed from the first to the Panama route, so now it alone can guide to the successful construction of the canal on that route.

We are convinced as firmly as ever that there is absolutely nothing in the facts which can or will prevent the complete and triumphant execution of the project, but that completion depends upon the full recognition of the truth. It must be accomplished by frank acknowledgement of and adjustment to the realities of the case and its surrounding conditions. The only serious misfortune which could come to the great enterprise taken over by the United States would be that which would follow any attempt to distort or conceal the truth about the canal work.

This truth, both as to the physical elements and the surrounding conditions, we hope through Mr. Wallace's articles to make fully manifest. The necessary action may safely be left to enlightened public opinion.

* * *

To Mr. Stevens, who succeeds Mr. Wallace as Chief Engineer of the Panama Canal and who comes to the undertaking with the confidence warranted by a record of large accomplishment and excellent administrative ability, displayed in the upbuilding of transcontinental railways, we wish the utmost success. If he finds in his new relations the same power and freedom to express his professional knowledge and skill in constructive work which he has found in the positions wherein he made his reputation, unquestionably he will carry the undertaking to success and his own fame to higher prestige. If, on the other hand, he should find that Government systems and methods, departmental routine, and political standards, are wholly incompatible with the policy and ideals he has found it essential to live by in order to carry out the executive direction of great enterprises, he would in all probability feel compelled by every consideration of professional pride and honor to dissociate himself again from work which he felt it impossible to administer properly under the conditions by which he was surrounded.

In our judgment, the one great menace to the speedy and successful completion of the Canal construction is that, in the management of its affairs both large and small, the Government official and the departmental idea is ascendant over the practical engineer and the engineering idea. That the Government must control in theory, and, as to great questions, in absolute fact, is indisputable. But practical execution of the project will never make adequate headway until the work is placed upon the same basis as other engineering undertakings of magnitude, such for example as the great railway and subway enterprises—committed to a management of unquestioned ability and unimpeachable integrity, with a free hand. The Canal must be built by engineers; it can not be successfully built by politicians.

* * *

THE deplorable accident which occurred near Mentor, Ohio, with the Twentieth Century Limited train of the New York Central and Hudson River Railroad (not the least of its deplorable results being the deaths of Messrs. C. H. Wellman, T. R. Morgan, and Archibald P. Head, widely known in engineering circles) cannot properly be attributed to the high speed of the train, since the cause of the disaster—a misplaced switch—would have made even a worse wreck of a slower train. The disaster is but another argument for the introduction of absolute mechanical control of all operative features in the maintenance of a clear track, a control which shall automatically apply the brakes and compel a stop if, for any reason the way shall not be complete.

Experimental researches, upon the Marienfelde-Zossen electric railway in Germany, have developed the impor-

tant fact that at the highest rates of speed it is impracticable to depend upon the human perception of the condition of stationary signals, and it is being planned to transfer the signals to the cab in which the motorman is placed, thus enabling him to have before him an electrically controlled indication of the warnings and directions which he might well fail to observe in the infinitesimally short space of time available for the passage of a fixed signal. Similar experiments are in progress in the tunnel of the New York Central and Hudson River Railroad, wherein the dimness of the light interferes more or less with prompt discernment of the hitherto customary signals.

* * *

THIS feature of efficient transport is one which cannot be emphasised too strongly, since it involves a point which appears in various forms in different departments of engineering work. The specialist, devoting himself to some limited portion of an operation, often sees no further, and having accomplished the best result practicable within his limits, fondly imagines that there is nothing more to be done, forgetting that it is the ultimate undertaking which must be considered. The steam engineer often aims to design an engine which shall produce a horse power with the very smallest quantity of steam, while by so doing he adds to the fixed charges an amount which really increases the total cost of the motive power of the establishment. The great ocean liner may break all speed records only to become a heavy source of loss to the company because of the total lack of cargo capacity, and the enormous fuel consumption.

Fortunately the engineer, in becoming, as he is, a man of business affairs as well as a man of applied science, is beginning to realise that the great works of which his efforts form a part are to be considered broadly, and that it is not alone the high spurt of speed, or the low consumption of fuel per horse power, or the isolated *tour de force* in any instance, which is to be considered, but the successful accomplishment of the whole undertaking in the broadest possible manner.

* * *

The ancient ethical formula, known as "The Golden Rule" appears to be appealing not merely to the consciences, but to the pockets of some employers. These claim that attention to the personal comfort and moral surroundings of the employed results not only in laying up treasure in heaven, but increases earthly dividends, presumably, the latter motive in these money getting days being controlling with the majority of business men. Once convinced it is pecuniarily profitable to make surroundings pleasant in manufacturing establishments, we shall doubtless soon perceive a great amelioration in the conditions which now environ manual workers in some departments of industry. How far this can be carried without weakening discipline, or lessening production is a problem not yet worked out to a final solution; but some indication that increased attention is directed to this feature of manufacturing industry may be perceived in fragmentary allusions to the subject in the technical press. It is certain that the conditions which surround labor in many of its most important fields are such as to create the desire for improvement in the minds and hearts of disinterested and philanthropic observers. But it must always be borne in mind, that toil cannot be made synonymous with ease, and that toil is the price of progress in all callings. Some of this toil which is indispensable must be performed in an environment and under conditions that will ever remain repellant.

* * *

AMENDMENT of some terms used in engineering, or the substitution for

these terms of more definite terms of expression, is one of the ideas suggested by perusal of Mr. R. M. Neilson's able article on "The Effects of Vacuum on Steam Economy" printed in the present number of this magazine, where he remarks that "it is a pity that condenser pressures are usually expressed in inches of mercury of vacuum instead of as absolute positive pressures." The predication of something positive concerning a negative quantity is an error referred to in all standard treatises upon logic, as liable to lead to erroneous conclusions, and mathematicians will readily recall the ancient trick of making a false proposition appear to be true, without violating algebraic rules, through the use of an indeterminate quantity as a factor in algebraic equations. Other terms long used in engineering technology might be advantageously replaced by terms of more definite import. Why, in indicating pressures of steam or of compressed air, should we be obliged to append the word "absolute" or "gauge" to make clear what is intended? Why should not all pressures be expressed in absolute terms? Prof. Kent, the well-known compiler of engineering data, has gone on record as advocating the substitution of an expression for resistance to passage of heat through materials, instead of an expression of conductivity, and has supported this view with ability. Why should we not always express temperature as reckoned from the absolute zero, a thermometric point established by nature, instead of the arbitrary zeros established by the devisers of arbitrary thermometric scales? If the entire field of engineering technology were scanned for the discovery of terms that have descended to us as an inheritance from eras of imperfect knowledge, it is probable that a number more of these questionings would be suggested.

THE discussion of the subject "Progress in Valves of Air and Gas Compressors," by Mr. Leicester Allen in our July number, and an article on "Temperatures in Air and Ammonia Compressor Cylinders," by the same writer, in the current number in connection with the review of Mr. A. L. Mellanby's paper on "The Influence of Steam Jackets" on page 755 of this number serve to illustrate the lack of accurate data relating what takes place in reciprocating engines and pump cylinders while working under approximately the best attainable conditions. The "missing quantity" is demonstrable in all engines and compressors whether steam engines, air compressors or compressors of gases which liquefy by cooling after compression, being least in the compression of air and gases which do not so liquefy. It is inseparable from the operations of either expansion or compression of any one of this class of substances. Among the factors of this missing quantity Mr. Mellanby believes that slippage of live steam into the exhaust ports of slide valves plays an important part, a fact which has also been pointed out by Professor Peabody, and other investigators. The existence of this slip may be considered as an established fact. Doubtless, it varies with different types of slide valves, and is influenced by the perfection or imperfection of fitting, as well as the changes which heat effects in the metals used for the valves and their seats. This view is sustained by the fact that before some types of slide valves can be made to seat even with approximate perfection when live steam is regularly passed through them their seating must be tested by working under steam at the pressure to which they are designed to be subjected in actual work; and, if examination after such testing indicates defective seating they are scraped, often repeatedly, till the indications of imperfect seating disap-

pear. How much of the distortion produced by expansion and contraction becomes permanent after such attempts to perfect the fitting is believed to be an unknown quantity. If a slide valve be perfectly fitted to its seat and prevented from lifting it is difficult to explain how steam in quantity sufficient to generate a notable loss, can pass from the steam chest into the exhaust without first traversing the cylinder. Slip from imperfect fitting of pistons, seems as likely to occur as valve slip, and indicator diagrams should reveal such a defect if it exists in more than extremely limited measure.

* * *

THE defect of valve slip is not confined to slide valves; and although poppet valves may be ground so as to be very tight when at rest under pressure, there is room for more than a suspicion that, while working, more or less leakage constantly occurs with them. The causes of this leakage are well understood, but it is very difficult to avoid them all in practise. Such valves, tested for accuracy of fitting, and, seemingly, satisfactorily meeting the test applied, may in a short time work defectively. Till the arts of valve fitting and piston packing advance to greater perfection there will remain the "missing quantity;" jacketing cylinders will never alone eliminate it from the equation.

* * *

CAN the enormous increase in the output of gold predicted by Mr. Del Mar in the leading article of the current number of this magazine take place without cheapening this metal in the world markets? If so, gold will prove to be an exception to all other articles of merchandise. There are many, indeed, to whom the word gold has been "polarized" in its signification, as our honored, American philosopher, Oliver Wendell Holmes would have said, till it has come to mean in their thinking money only; but there are those who will remember that the demonetization of silver reduced silver, long ranking with gold as a medium of exchange, to a value far below the current value it previously had as money, and that such demonetization by the United States Government was largely caused by the enormous increase in the output of silver. Baron Rothschild is stated to have expressed his belief in the probability that a similar effect upon the price of gold would result from a possible great increase in its output.

* * *

IT is difficult to predict all the effects of great revolutions in any of the industries of the world. But if any one principle of political economy can be accepted without reservation it would seem to be that, where the laws of trade are permitted to work without obstruction or interference, great expansions in production are accompanied by contractions in prices. John Stuart Mill, in his writings on the subject of political economy, declares explicitly that whoever sells anything, receiving money as payment, buys the money as well as sells the goods. What, then, is there in the nature of gold considered as either merchandise or money that will prevent its decline in value, as a result of the expected great increase in the quantity annually thrown upon the market? To be sure, modern commerce is not entirely free from interference with its natural flow. The world does not yet know exactly how to deal with giant syndicates that seem to have been the logical outgrowth of the rapid industrial and commercial evolution of the last three decades. If such an impulse to commerce as would follow the doubling of gold production in ten years is to come, the political and social problems

that will inevitably press for solution will be of such magnitude as to tax to the utmost the resources of statesmanship, already seemingly taxed nearly to the limit.

* * *

In view of the developments in the financial world which are shocking public faith, it is not surprising that many who take a pessimistic view of the financial outlook should be apprehensive of a disturbing effect of such sudden and large increase of gold as is prophesied by Mr. Del Mar. The doubling within ten years of the product of any of the world's staples, could not fail to create unprecedented effects upon the markets of the world. The imagination struggles in vain to form a vivid conception of what results would follow the doubling in so short a time of the wheat crop, or the cotton crop, other production remaining about the same, but the status of gold with relation to all other staples of modern commerce is such that its volume could not be suddenly and largely swelled without affecting the price of every other product.

* * *

The discomfort of foul smells and dust in the New York subway are attracting attention. It is impossible, in such a confined space, traversed daily by many thousands of all kinds of people, to prevent a considerable and heterogeneous deposit of organic matter, much of which, particularly cigar stumps, discarded tobacco quids, and fragments of confections and other articles of food which children are permitted by indulgent parents to enjoy while riding in the subway cars, the refuse of which is thrown upon the roadbed from platforms of cars and stations, or tossed out of car windows, becomes a constantly present source of foul smelling emanations. It seems that there is as much need of devising some practical way of cleaning the roadbed, as of supplying more fresh air in the tunnel. It was probably supposed that impure air would be intermittently forced out of the entrances and exits at the stations in currents generated by the movement of trains, and that fresh air would flow in at the same openings, also in an intermittent manner, to supply the place of the vitiated air so expelled. This expectation if it was entertained, has certainly not been fulfilled, at least in such satisfactory manner as to meet the requirements of good ventilation. Those who have regularly patronized the subway complain much of the peculiarly offensive dust, and the odor emanating from the drippings of lubricating oil distributed along the entire track. The four tracks, with trains running on them at short intervals, in opposite directions, operate to generate violent eddies rather than steady air currents setting in any single direction, such eddies acting to keep all floating impurities from settling, whereas they should be carried out of the tunnel to gain the degree of purity which is desirable. Experiments with fan blowers for increasing ventilation are stated to have been inaugurated. To those whose business compels the daily use of this means of traffic, any scheme of really effective ventilation would be most welcome, for it must be admitted that traveling in the subway is still far removed from a degree of refinement that can be accurately characterized as luxurious.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

AMERICAN BRIDGE BUILDING.

A REVIEW OF THE DEVELOPMENT OF MODERN METHODS OF BRIDGE BUILDING IN AMERICAN PRACTICE.

C. C. Schneider—American Society of Civil Engineers.

IT has become the accepted practice among the leading American engineering societies for the president in his annual address to discuss some department of engineering work with which he has himself been actively identified. The result has been the production of a number of papers which may be termed monographs upon the leading departments of engineering, valuable especially because they represent the actual experience of eminent and successful engineers.

At the recent convention of the American Society of Civil Engineers, the president, Mr. C. C. Schneider, took as the subject of his address the evolution of the practice of American bridge building, from which we make some abstracts.

Mr. Schneider reviews the history of early bridge building in the United States, describing the excellent work done in the construction of timber bridges by the carpenter builders before the introduction of railroads. After the development of railways, beginning in 1829, iron bridge building began, and many of the earlier iron bridges were directly imitated from the earlier wooden structures. It was not until Whipple evolved the scientific method of bridge designing and building that the correct method of determining strains was used, this being followed, in the period between 1850 and 1860, by the work of Fink and of Bollman, and by the construction of the Whipple and the Pratt trusses.

In these early bridges cast iron was extensively employed, wrought iron being used in the tension members only. The wrought iron tension members at that time usually consisted of round bars with screw ends, or elongated links made with square bars. The latter construction developed into the flat eye-bar, this being due to Linville, in 1861, and forming a distinctive feature in American bridge design ever since.

"Near the end of the sixties, when most of the early bridge companies had been formed, there were, besides the engineers interested in bridge building firms, only a few experienced bridge engineers in this country. The engineers who were at that time connected with bridge companies were mostly men who had gained their experience in the employ of some railroad company, had worked out their own type of construction, and had experience, not only in designing, but also in superintending the construction and erection of bridge work. Their theoretical knowledge, measured with the present standard, was limited to elementary methods, but their thorough practical training enabled them to combine theory and practice to the best advantage. They understood how to make their designs conform to the methods of the workshop, as well as to facilitate erection.

"This was really the beginning of the development of American bridge building and of the distinctly American types of construction which at that time differed so materially from those of other countries. The most distinguishing feature of the methods then prevailing in this country, as

compared with those of other countries, the influence of which is felt to the present day, is that at that time in America the bridges were designed by experienced specialists, and the work was constructed in shops built and equipped for that special purpose by experienced mechanics trained in that class of work. At first these companies controlled the work in certain territories, or the contracts were awarded to them on account of the reputation of their engineer.

"However, as competition became keener, railroads desired to purchase their bridges for the lowest price, and invited several firms or companies to submit tenders on the bidders' own designs, which started the competitive system of designing and bidding on bridge work."

It was not until about 1872 that the modern specification method came into use, the general requirements only being stated, and the design of the structure and the proportioning of details being left almost entirely to the builder, the bridge being accepted on his reputation. After 1873 the modern bridge engineer appeared in the field and the employment of inspectors of material and workmanship was included. From the construction of the Eads bridge accross the Mississippi at St. Louis in 1874, down to 1894, wrought iron was gradually replaced by steel, and at the present time it is practically impossible to obtain wrought-iron shapes.

"The use of steel in the construction of modern bridges, and the improvements made in its manufacture, thereby reducing its cost and increasing its reliability, have made it practicable to build structures of a magnitude never attempted before. Its introduction as a structural material had a marked influence on the progress and development of bridge building. Certain types of construction and details which have proved unsatisfactory have been discarded, and others which have undergone a process of purification and improvement have survived. Rational types of construction and details are now established, and have become the recognized standards for ordinary bridges of moderate spans. The present tendency is toward uniformity, and to-day there is but little difference between the designs made by competent engineers.

"This tendency toward uniformity has also been extended to specifications for bridges and other steel structures, relating to quality of material, workmanship and unit strains. As late as five years ago, the requirements specified for the quality of steel were numerous, almost every railroad or bridge engineer requiring some different grade, and sometimes several different kinds in different parts of the same structure. Erratic specifications are now gradually disappearing, and engineers at the present time are nearly all agreed on the grade of steel best suited for structural work."

At the present time there is a tendency towards closer uniformity between European and American practice in bridge building than formerly, each country gradually adopting the good points in the other's practice. Designs have been materially modified by reason of the steady increase in the weights of locomotives and rolling stock, while bridges are now expected to be able to stand up under the ordinary contingencies of traffic, such as derailment, a broken axle, or a collision on a bridge.

"Any engineer who has followed the progress of American bridge building for the last 35 years must have observed that, not only the designs, but also the methods adopted for accomplishing results, have undergone a vast transformation; while, abroad, the designs have beenn improved, but the methods have changed very little, if at all.

"The practice of having designs of bridges and other structures made by engineers employed by the purchaser, and letting the contract to a manufacturer on a pound-price basis is now becoming the standard practice of the country. Most of the large railroads have their own bridge and structural departments, or, for work of unusual magnitude, employ outside experts to design and supervise construction. Only a few of the smallest railroads adhere to the ancient practice of inviting manufacturers to submit competitive designs accompanied by a lump-sum bid.

"The competitive system has had its day and has served a good purpose. It has been an important factor in developing the art of bridge building in America. It has been productive of establishing rational types, practical details and scientific proportions; it has united theory and practice.

However, at present, it is fast becoming a thing of the past. What is left of this practice is mostly confined to bridges for electric railways and light structural work. Many purchasers of structural work, who have had no experience themselves, do not seek professional advice, as they would in other cases where large expenditures of money are involved, believing that they can save the money paid for professional services by inviting manufacturers to make competitive designs accompanied by a lump-sum bid. The fact is, however, that the manufacturer has to pay for making the designs not only once, but many times over, as only once in a number of cases is he the successful bidder. The manufacturer will naturally add this extra expense to the cost of the structure, yet the designs are not made in the interest of the purchaser, but in that of the manufacturer. This practice has a demoralizing influence, as it puts a premium on the poorest design and tends to decrease the professional standard of an important branch of engineering.

"The standard practice to be recommended, as the only fair and businesslike method, is to let contracts for structural steel work on a pound-price basis, on designs and specifications furnished by an experienced engineer employed by the purchaser. This method is fair to the honest manufacturer, as all competitors bid on the same basis; it is an advantage to the purchaser, as he employs the engineer who will protect his interests, study the conditions and requirements, and design a structure to suit the needs of his client. It will benefit a number of engineers, who are now compelled to waste their time and energies in making speculative designs to suit the commercial interests of a manufacturer, regardless of good practice, by elevating them to more independent positions, thus enabling them to raise their professional standards to the highest ideals of good practice."

Mr. Schneider distinguishes clearly between the work of the engineer and the bridge builder, and his remarks in this matter may well be applied to other departments of engineering work, notably to the design of tall buildings, dams, embankments, and similar structures.

"Plans for bridges and other structures, on the safety of which the lives of human beings depend, should be designed and not manufactured; their design and the supervision of their construction should be entrusted only to competent engineers, who, besides the requisite theoretical and practical knowledge, should, above all, be endowed with common sense and good practical judgment.

"Most of the largest bridges and other steel structures which have been built in later years have been designed by engineers not connected with manufacturing establishments. The manufacturer should confine himself to his legitimate field of manufacturing structural work at so much a pound.

"The line between engineers and manufacturers will be even more marked in the future, when the same distinction will prevail as now exists between the architect and the contractor. The manufacturers of structural work, in the future, will devote their energies to improvements in their tools and machinery and methods for handling material. Their engineering force will consist of mechanical experts, shop draftsmen and engineers, who, with a thorough knowledge of shop-practice, are skilled in putting the engineers' designs into convenient shape for the workshop."

LARGE GAS ENGINES.

RECENT DEVELOPMENTS IN THE DESIGN AND CONSTRUCTION OF LARGE GAS ENGINES ON THE CONTINENT.

R. E. Mathot—Institution of Mechanical Engineers.

IT is a matter of interest to note that the development of the gas engine has varied greatly in different countries. In England, and to a great extent, in the United States the small engine has been extensively made and used, the advantages of convenience outweighing the cost of illuminating gas as a fuel. On the Continent, however, the gas engine first developed into a machine capable of entering the field of prime movers of large size, competing with the steam engine in di-

mensions and power, and far excelling it in thermal efficiency.

At the Liége meeting of the Institution of Mechanical Engineers, Mr. Rodolphe Mathot, well known to the readers of this magazine as an authority on gas-engine design and operation, presented a paper upon the growth of large gas engines on the Continent, showing the extent to which the internal-combustion motor has become a competitor with the steam engine in Europe.

"The development of large gas-engines can be said not to date back further than five to six years. Eight to ten years ago they were initiated simultaneously in Germany, England and Belgium, early attempts being made to utilise blast-furnace gas, which was expected to open up such a vast field for the employment of large engines. Although the first trials were only attempted on small engines, the results of the experiments soon gave encouragement to the efforts of the investigators. The Cockerill Co. of Belgium constructed a single-acting Otto cycle engine of 200 horse power, which has been working regularly at their establishment for six years. This stage in the path of progress was strongly accentuated by the 600 horse power engine on the Delamarre-Debouteville system, which the Cockerill Co. exhibited at the Universal Exhibition at Paris in 1900. This magnificent engine was single-acting, the piston having a diameter of 1.300 m. and a stroke of 1.400 m. It was designed to develop its power at 80 revolutions per minute, which, with an initial explosive pressure of 310 to 325 lbs. per square inch, produced on the piston a pressure of 300 tons at each explosion. In a short time several famous firms entered, in their turn, upon the construction of large engines intended to utilise the gases liberated by the various reactions occurring in the manufacture of iron, coke, &c., and the metallurgical industry was not long in entering upon the path of progress by replacing for its old boilers and engines powerful installations of explosion engines. It remained, however, to conquer the vast domain of manufacturing industry. It is in this sphere that the struggle is taking place with the steam-engine, which a long career has endowed with improvements in methods and execution. The physical laws which govern the production and utilisation of steam as a motive power have long been known, having at an early date emerged from the obscurity which developed their interpretation, and thermodynamic science has given them definite sanction by numerous investigations.

"Improvements in construction advanced side by side with the progress of scientific theory to accomplish mechanical marvels. Steam is, however, a fluid much less complex in nature than explosive mixtures. The action of steam is governed by precise laws which pertain only to the sphere of physics, whilst the production of combustible gases and their mode of evolution under the form of explosive mixtures in engines, are as much within the domain of chemistry as of physics and mechanics. Although the generic theory of gas-engines has rested up to the present on a series of hypotheses which have not yet received experimental confirmation, these engines have gained ground in application to various industries with exceptional rapidity compared with any other kind of motive power. The invention of gas producers and the improvements made in the last few years, and especially in those working with the direct suction of the engines, are manifestly most important factors in this success."

In discussing the various elements involved in the operation of the gas engine, Mr. Mathot considers first the question of regulation, showing how the "hit-and-miss" method, so generally employed for small engines, has been entirely abandoned for the larger machines. The present methods act by controlling the mixture of the charge, and especially by the admission of a variable quantity of a mixture of uniform composition. A variety of admission valve systems are shown in the paper, using auxiliary throttling valves, valves with variable stroke, and similar devices.

The valve control, in the modern large engines, resembles somewhat that of the best types of poppet-valve steam engines, such as the Sulzer engine, cams being replaced by eccentrics and roller-path levers.

The question of cooling demands especial attention in large gas-engines, since

the heavy pieces are extremely liable to crack if unequally heated. The method of circulating the cooling water has an important influence upon its effective action, the best effect being obtained by placing the inlet and exhaust valves in the same vertical axis, both being in a passage, or ante-chamber, surrounded on all sides by the cooling water. For engines of 100 horse power or more the exhaust valve is also provided with an internal circulation.

The advantages of high compression are fully realized, and at the present time the compressions used range from 170 to 200 pounds per square inch. The head produced by such a compression is liable to cause pre-ignition if the cooling is not effective, and in the Koerting engine there is a hollow casting arranged inside of the explosion chamber provided with a special water circulation for cooling purposes. In double-acting engines the water cooling includes not only the cylindrical jacket and cylinder ends, but there is also provided an independent water circulation for the piston and piston rods, the seats of the exhaust valves, and the stuffing boxes.

An important feature in the successful operation of the internal-combustion engine is the ignition, and at the present time the use of the magneto, producing a spark on the break of the circuit has ousted all the older methods of ignition, such as the incandescent tube, the spark produced by batteries and accumulators, by dynamos, etc. The use, in large engines, of greater volumes of lean gas has led to the use of two igniters, one placed near the inlet valve at the top, and the other at the bottom near the exhaust valve.

Large engines are now generally started by compressed air, a lever or system of gearing being used to bring the crank to the correct position.

Mr. Mathot gives formulas for the computation of the proper weight of flywheel for engines with various arrangements of cylinders, and for different classes of service, and also discusses the various systems of lubrication in use.

The mechanical efficiency of the four-cycle engine now reaches as high as 90 to 92 per cent., while the two-cycle engine attains about 75 to 80 per cent., the difference representing the work absorbed by the air pump and the gas pump. The thermal efficiency of the double acting four-cycle engine may be as high as 28 to 30 per cent., corresponding to the production of a horse power with an expenditure of 8,729 British thermal units per hour.

The details of modern large gas-engines are very fully shown in Mr. Mathot's paper, these representing the practice of the best modern builders of the Continent, the performance being shown by indicator diagrams. Even with all the care and skill which has been given in design and construction there are certain difficulties which remain to be overcome in order to enable large engines working with lean gas to work with safety, facility of control and satisfactory upkeep.

"Economically the gas-engine is evidently superior, but low consumption is not the only quality which users require from a motive power. It is necessary above all that it should be free from the risk of sudden stoppages which lead to great expense, as they hamper production and may be at times fatal in certain industries where breakdowns must be specially avoided; such is the case with electric stations, pumping, hoisting and ventilating work in mines, etc. The principal causes of breakdowns in engines fed by gas other than town gas, which undergoes a complete purification, consists in the fouling of parts, such as the pipes, the valves and the cylinder, by impurities in the gas.

"In large installations where it is extremely important to avoid breakdowns, recourse is had to special means of washing and purifying, by the use of centrifugals and other apparatus. But although these succeed in reducing to 1/5 gramme per cubic metre the amount of dust accompanying the gas, they still allow the passage of tar, which is the principal element destructive to the engine. This tar adheres to the sides of the passages, causes the valves and piston-rings to stick, thus preventing their proper action. It also deposits itself in the cylinder where it finally gives rise to premature ignitions. Certain coke-oven gases contain as much as 1 gramme of tar per cubic metre. It is this very question of tar which compels us, in order to avoid great complications, to em-

ploy exclusively non-caking anthracite coal for suction gas-producers now so largely in use owing to their simplicity and economical efficiency. As tar is a product of distillation of the volatile carbons (carbides) which escape on combustion and on the conversion into fuel gas, it is to our interests to reduce them in the producer itself. Different systems have been proposed, amongst which is the system of *inverted combustion*, which is said to have the result of burning the volatile matters as they are given off and the *distillation* of the hydrocarbons in the independent reducers. It must be admitted that so far the efforts of the inventors have not met with the success expected. The caking of the fuel and the formation of cavities injurious to the regularity of combustion constitute the principal difficulty to combat. The use of bituminous coal, especially in suction gas-producers, is not therefore a question which has been industrially accomplished.

"Whether it is producer gas, blast-furnace gas, or coke-oven gas which is used, their purity is an important factor in the proper working of the engines which they feed. The organic defects of large engines do not appear to play in this respect a preponderating part. They should, however, be perfected as regards facility of access and upkeep of the parts, such as valves and piston. The oil consumption should be low, and they should be made less susceptible to variations in the quality of the gas. The skill of our experts and our makers will, we have no doubt, soon overcome these latter difficulties. Large gas-engines will then constitute one of the most remarkable industrial victories of the age in which we live."

ELECTRIC POWER SUPPLY.

THE PRACTICABILITY OF SUPPLYING CHEAP ELECTRICAL ENERGY FOR INDUSTRIAL PURPOSES.

J. A. Jeckell—Birmingham Electric Club.

MUCH has been said and written about the engineering features involved in the establishment and operation of electric generating stations, but it is not always realized that the fundamental object of such undertakings is not to make electricity, but to make money. For this reason the paper recently read before the Birmingham Electric Club, by Mr. J. A. Jeckell, is of value, treating as it does of the commercial side of electric power supply, and of the advantages to be gained in the reduction of costs to the producer and of prices to the consumer.

In the early days of the introduction of electricity the current was mainly used for lighting, and the original customers paid a high price for the supply, so that good dividends were made without requiring close attention to be paid to the cost of operation. The stations were engaged in supplying what has been termed the luxury demand, which was very satisfactory while it lasted, but could not wisely be taken as a basis upon which to plan future operations.

The true methods upon which a commercial undertaking of this sort should be carried out are clearly stated by Mr. Jeckell to be: the expenditure of the smallest amount of capital; the production of the article at the lowest possible figure; the selling of the largest possible amount of that article; and an arrangement by which the payment of the manager may largely depend upon the financial results which obtains.

"When local authorities decided to undertake the supply of electric energy, the only course open to them was to consult an expert. Unfortunately, from the view of profit-making, the consulting engineer was not in every way a most desirable person to give advice; being pre-eminently an engineer, he would naturally not look so much to the commercial aspect of the undertaking as he would to the engineering side. It should be remembered that for an engineer commercial knowledge is in some ways a disadvantage. Undoubtedly there is another side to the question, but in successful engineering money may have to be a secondary consideration, and therefore it is not to be expected that consulting engineers should be good commercial men. It is well

known that consulting engineers are paid a percentage on the capital outlay, and, therefore, while for not one moment suggesting that a good consulting engineer would on this account recommend increased expenditure, still it must not be forgotten that this percentage does not depend upon the commercial success of the undertaking. Furthermore, the number of consulting engineers who had actually designed, put down, run, and made a commercial success of an electricity supply station was, and is still, limited.

"The old Latin proverb *Experientia docet* has a great deal of truth in it, and unless a man is a Heaven-born genius, of which there are few examples in this world, he is not likely to be well acquainted with matters of which he has not had previous experience. However, for local authorities there was no choice in the matter; they had to go to the only men available to advise them with regard to putting down their works. These engineers would be inclined to follow the principle adopted frequently in gas and water works, and erect fine handsome buildings, which are all very well in their way, but do not reduce the cost of manufacture. Further, these engineers took far too limited a view with regard to the supply of electricity in the future. Stations were designed purely for lighting purposes, and too frequently no provision was made for large future extensions. Further, these engineers who designed the stations apparently favoured land practice rather than marine practice. It is, of course, well known that it is more important to have highly economical engines on board ship than on land, because in the former case not only has coal frequently to be purchased at foreign ports at an enormous figure as compared with the prices ruling in England, but for every ton of coal not required a ton of cargo can be carried. Marine practice was, therefore, to use the most efficient steam-engines possible. Compound condensing engines had given place to the triple-expansion condensing engines, and these in many cases had been superseded by quadruple expansion engines. Engineers who designed the electricity works, for the most part, ignored all this experience, and installed compound engines non-condensing, either horizontal or vertical. Of course, these were cheap to buy, and as long as electricity was only used to meet the luxury demand for lighting, the load factor of the plant being only some two hours per day, the want of economy of this type of plant was not of so much account."

Mr. Jeckell gives practical illustrations of the working of actual stations, showing the advantages to be obtained by the careful design of plants capable of economical performance over a long range of power. Such installations include the use of large, surface condensing power plants, instead of small non-condensing engines, the irregularities in the load being taken care of by the power range of the engines instead of attempting to throw smaller engines in and out of service to meet the fluctuations in the demand.

"The chief thing we have to bear in mind with regard to the supply of electricity for power purposes is that the energy must be sold cheaply. In order to do so we must get down to the rock bottom cost of manufacture. In considering this question, the *capital* cost of the plant is really a secondary consideration, because if the plant is run 12 hours per day the capital is not increased, but, on the other hand, the maintenance is probably increased, the wages are increased a little, the oil is not increased much. The chief item we have to consider is the coal consumption, because after the stand-by charges are paid the coal consumed will be in proportion to the number of hours the plant is run. The author particularly wishes it to be understood that he does not mean that the open-type marine condensing engine is the *only* engine for use in power stations. The moderate-speed enclosed type and the turbine under certain circumstances will probably do equally as well, but local conditions will decide this."

As an example of the manner in which the cost per unit can be lowered by a judicious rearrangement of the plant, combined with a vigorous effort to increase the output and sale of current, Mr. Jeckell cites the case of the Coventry Corporation Electricity Works. Here a plant which was yielding no profit was extended by an expenditure involving a doubling of the capital, while the amount of current sold

was increased more than six-fold. The station cost per unit, or kilowatt-hour, was reduced from 3.43 pence to 0.85 penny, while the price to the customer was lowered from 4.27 pence to 2.28 pence. At the same time the profit was increased from 1.44 per cent. to 6.47 per cent. upon the total capital, and deducting the profit made in 1900 upon the original capital, it appears that a profit of more than 10 per cent. has been made upon the extra capital spent since that date.

That the supply of electricity for power purposes at a very cheap rate is advantageous would seem to appear without requiring demonstration, but Mr. Jeckell gives a number of arguments to show the especial advantage to the United Kingdom of a cheap supply of electric current. Thus the severe competition which British manufacturers are obliged to meet renders it especially important that power should be supplied to manufacturers at a low price. Again, the provision of a supply of cheap power will aid in maintaining the industries of the smaller towns, and prevent them from being suppressed in favor of the larger manufacturing centres. The advantage of this from a sanitary viewpoint is fully admitted, while the commercial gain is also evident. The general introduction of electric power distribution would also result in an increased development in the business of the manufacture of electrical apparatus, cables, motors, and other machinery, so that the results of a cheap and abundant supply of electrical energy cannot but prove a great benefit to the nation, to the various localities, to the public health, and to the undertakers.

AUTOMOBILE MILITARY TRACTION.

THE APPLICATION OF AUTOMOBILE HAULAGE TO HEAVY ARTILLERY SERVICE IN THE PORTUGUESE ARMY.

Col. G. Espitallier—Le Génie Civil.

THE applications of automobiles to military service have thus far been attended with but limited success. Experimental trials have been made in England with machines especially designed for this service, and some fairly satisfactory results obtained. At the same time, the onerous conditions have prevented complete success from being attained, and it is undoubtedly the opinion of most military men that the vigorous service now rendered by horses cannot be effectively replaced by machinery. At the same time there are certain departments of military work, involving the haulage of heavy trains of artillery or munitions along regular highways, in which the automobile may well be found more effective than animal traction, and to this matter serious attention has been given in various countries. In a recent issue of *Le Génie Civil*, Lieutenant Colonel Espitallier describes the efforts which have been made to apply automobile traction to a battery of heavy artillery in the army of Portugal. As this battery represents the latest work of the great Creusot Works it cannot be regarded as an ill-considered experiment, but rather as a serious effort on the part of an establishment of high reputation, to solve a difficult problem.

In the trials made in England under the auspices of the War Office, it was decided that steam vehicles were inadmissible for military purposes, owing to the difficulty of obtaining water, and, indeed, this appears to be an insurmountable obstacle, especially in some parts of the world where mechanical traction would be most desirable. Apart from the question of water supply, there are other objections to machines using coal or coke as fuel. The weight of the fuel alone is a serious matter, and it has been estimated that a motor of 25-horse power would require about 80 kilogrammes of combustible, and 400 litres of water per hour, all of which would, in most instances, have to be carried, thus seriously diminishing the effective capacity of the machine. The production of smoke by day and of sparks by night, form also serious defects in a machine intended for military service. For these reasons it was decided to rely upon an internal-combustion motor, and in the case under consideration it was decided to use a motor of the Brillie type.

The battery to be hauled consisted of four Canet guns of 150 millimetres bore and 14 calibres length, throwing a projectile of 40 kilogrammes weight with a velocity of 350 metres. The full road weight of the train, including the four pieces, with supplies, ammunition, spare parts, etc., including the automobile tractor itself, amounted to 26 metric tons, the machine alone weighing seven tons.

The motor is a four-cylinder machine, developing 35 horse power at 900 revolutions, and is arranged to use either alcohol or petrol as fuel. The speed gear is arranged to permit four changes, ranging from 2.4 kilometres to 14 kilometres an hour on the road. In actual service it has been found practicable to maintain a speed of five to seven kilometres per hour upon a good level road, this speed falling to two to three kilometres up grades of 5 to 7 per cent.

The consumption of fuel is found to be about two litres per kilometre, corresponding to 0.075 litre per ton-kilometre total. The machine is arranged to carry 180 litres of fuel, and 30 litres of water, this being sufficient for a journey of 80 kilometres in length.

An important feature of the machine, and one adapted from experience with the Powler traction engines in the British service in South Africa, is the provision of a winding drum on the tractor. By this means it is practicable to overcome heavy resistances or to pull the train out of a bad piece of road or up a heavy grade, using a wire cable, and either attaching the rope to a fixed point ahead and winding up the whole train, or else sending the tractor ahead and using it as a winding engine to pull up the balance of the load.

It is apparent that if automobile traction is to find practical application in military service it must begin by some such intermediate work as that here described. The field battery must be capable of being drawn into any position over any kind of country, and for this service there is nothing in sight which can approach animal traction. Recent military experiences, however, show that the ability to bring up promptly a heavy train of artillery even if limited to the lines of main highways, may be of vital importance, and the demonstrations which have been made with this equipment have shown the value of mechanical traction in warfare.

SUPERHEATERS FOR LOCOMOTIVES.

PRACTICAL EXPERIENCE WITH SUPERHEATED STEAM IN LOCOMOTIVE ENGINES IN AMERICA.

H. H. Vaughan—Railway Master Mechanics' Association.

AMONG the papers presented at the recent meeting of the American Railway Master Mechanics' Association was one by Mr. H. H. Vaughan, showing the remarkable extent to which the application of superheaters to locomotive engines has attained. Superheating was early recognized as of value for steam engines of all kinds, but after considerable experience it was gradually abandoned because of difficulties experienced with the lubricants, packing, etc. More recently its use has been revived, both in Europe and America, and with the improvements in methods and materials of construction the former difficulties have been avoided.

Although experiments had been made upon superheating in locomotives in the United States as long ago as 1870, the present interest in this line of work really dates from the more recent experiences of Garbe and Muller in Germany, and a paper of Herr Garbe, presented about three years ago before the Society of German Engineers, was reviewed at the time in these pages. At the present time it is estimated that there are about 200 locomotives in Germany running with superheated steam.

In America the Schmidt superheater, practically identical with that so successfully employed in Germany, was introduced by Mr. Roger Atkinson upon the Canadian Pacific Railway in 1901, and the results were so satisfactory that by 1904 41 engines were built equipped with the Schmidt and the Schenectady superheaters. During the present year, 1905, the Canadian Paci-

fic Railway is building 55 simple ten-wheel freight engines, and six Pacific type passenger engines, which will be equipped with superheaters of various designs, so that comparative results may be obtained. The design of superheaters used on locomotives is at present limited to three types. The original Schmidt design is provided with a tube of large diameter leading from the firebox to the front tube sheet, delivering a portion of the hot gases into an annular chamber at the front end, within which the supe-heater tubes are placed.

In the Pielock superheater the boiler flues pass through a superheating chamber in the middle of the boiler; while in the Schenectady superheater, and in a modified form of the Schmidt, the superheating tubes are inserted into the upper boiler flues, these being made larger than usual.

Mr. Vaughan gives results of a number of trials, both in Europe and America, showing in every case a material gain by the use of superheating. Broadly, the practical experience which has been thus far gained shows an economy of about 30 per cent., and it is upon this basis that the Canadian Pacific Railway Company has felt justified in going so extensively into the introduction of superheaters in its new engines.

"The use of superheated steam does not entail the multitude of practical difficulties that so generally accompany any invention or improvement that is introduced to improve the economic results obtained from a locomotive, and, indeed, it is probable that as experience with its application develops, some of the expenses that are incurred in the locomotive of to-day will be diminished rather than increased. There would only appear to be two possible sources of additional cost, the wear of valves and cylinders due to defective lubrication, and the cost of maintaining the superheater itself. So far as has been learned at present, the lubrication of superheater engines is not different from that of other engines, with the exception that the lubrication must be accomplished, and it is not sufficient to hope that the oil gets to the designed spot. For this purpose a positive feed lubricator is required, and this should preferably be provided with six feeds, so that pipes may be led to each end of the valve and to the cylinder. It should also be possible to vary considerably the amount of oil fed per minute, as superheater engines, even more than those of the ordinary type, require more oil when working slowly at long cut-offs, than at other times, on account of the high temperature of the steam being maintained throughout the stroke This can be effected either by supplementary oiling or by an easy adjustment of the lubricator, allowing a large amount of oil to be fed at low speed, but the latter will be preferable if obtained without complication. With proper lubrication there appears to be no additional wear of valves or pistons, and while a special mixture of metallic packing must be used, it has given, if anything, less trouble on the superheaters than on the other engines.

"The repairs to the superheater proper are at present difficult to determine; the smoke-box superheater certainly entails an additional expense when flues are renewed, as it has to be entirely dismantled in order to get at the tube sheet, but while it is said to have given some trouble in service in Germany, such has not been the case in three years' experience on the Canadian Pacific Railway. Some trouble was at first experienced with the joint between the large tube and the back tube sheet, but this was overcome by properly thinning the edges of the lap, as in fire-box construction. There has been no leakage from the various joints in the front end and, in fact, so far nothing has developed that would lead to any additional expense in maintenance.

"A possible advantage of superheating has not been utilized in its application in America, namely, a reduction in boiler pressure without loss in efficiency, although in Germany this has been usual. There is no doubt that the increase of pressure from 175 to 200 and 210 pounds that has taken place within the last few years has been of doubtful advantage. While there is a gain in economy, this is accompanied by an increase in the losses due to leakage, both in engine and boiler, and by a considerable increase in the cost and trouble of boiler maintenance. By superheating, the initial pressure becomes of less importance and with the proper amount of superheat, it will be possible to return to pressures of 175 pounds or less, without any appreciable loss

in economy, and with a relief from those boiler troubles, which have become more serious as the pressure has increased, it is probable that the saving from this cause alone will overbalance any additional expense connected with the maintenance.

"In general, it may be assumed that the maintenance of locomotives using superheated steam will not be necessarily greater than that of ordinary locomotives of similar size, as although certain additional expenses are introduced, these are offset by economies in other directions, and the net result will not be very much different. If this position is correct, the advisability of superheating depends entirely on the relation between the initial additional cost and the saving obtained, and as, at present, the cost of applying a superheater is about $1,000 per engine, and the tendency will be rather to reduce this amount than increase it, it is evidently a very good investment. A 200,000 pound freight engine making 30,000 miles per annum, will burn about 2,500 tons of coal, which at $2 per ton, costs $5,000, so that evidently a saving of 10 per cent. will pay 50 per cent. of the additional cost per annum, and it appears perfectly safe to state that with a superheater at least that amount can be saved. When slightly more expensive, at first cost, than compounding, there is in the application of superheated steam a possible development in locomotive engines, and without complication in its construction, which costs no extra for maintenance, does not reduce the efficiency of a locomotive in any way as a mover of freight, and which, without any desire to appear too enthusiastic, certainly promises to become one of the greatest steps in the direction of economy that has been introduced for many years past."

LIGHTNING PROTECTION.

MODERN METHODS OF PROTECTING BUILDINGS AND OTHER STRUCTURES FROM INJURY BY LIGHTNING.

Killingworth Hedges—Society of Arts.

IT is an interesting fact that one of the earliest practical applications of electrical research, the lightning rod of Franklin, should have had, first a great vogue, followed by a certain amount of discredit, only to be revived, under renewed conditions of scientific study and interest. The history of methods of protection against damage by lightning, together with a review of present approved appliances, forms the subject of an interesting address delivered before the Society of Arts by Mr. Killingworth Hedges, and published in the *Journal* of the Society.

After referring to numerous records of damage by lightning from very early times, Mr. Hedges describes the work of Franklin, in 1752, and calls attention to the fact that Sir William Preece stated before the British Association for the Advancement of Science in 1888, that if one wanted to know much about atmospheric electricity one had to go back to the works of Franklin, 140 years before. Down to the year 1881 there was not even a code of rules in the United Kingdom to guide people in protecting their buildings from the destructive effects of atmospheric electricity. At that time the first set of rules was framed by the British Association, but little was really done until 1901, when the Lightning Research Committee was organized in Great Britain jointly by the Royal Institute of British Architects, the Surveyors' Institution, and the Meteorogical Society. About the same time the Electrotechnische Verein, in Germany, took up the subject, discussing and framing rules and recommendations for the protection of buildings, so that the subject is now fairly on a modern scientific basis.

After describing the work of the Research Committee in securing reliable information concerning damage by lightning strokes, Mr. Hedges describes the modern theory of lightning discharges, and the methods of rendering them harmless.

"It has been pointed out by Sir Oliver Lodge that lightning discharges are of two distinct characters, which he has named the A and the B flashes respectively. The A flash is of the simple type which arises when an electrically charged cloud approaches the surface of the earth without an inter-

mediate cloud intervening, and under these conditions the ordinary type of lightning conductor acts in two ways; first, by silent discharge; and secondly, by absorbing the energy of a disruptive discharge. In the second type, B, where another cloud intervenes between the cloud carrying the primary charge and the earth, the two clouds practically form a condenser; and when a discharge takes place from the first into the second, the free charge on the earth side of the lower cloud is suddenly relieved, and the disruptive discharge from the latter to the earth takes such an erratic course that no series of lightning conductors of the hitherto recognized type suffice to protect the building."

Experiments show that the material of which a conductor is composed has an important influence upon the action. The disruptive discharge to copper is far louder and more intense than that to iron, while that to wet string was still quieter. It is interesting to recall in this connection the fact that in the famous experiment of Franklin, the wet kite string formed the conductor. The experiments show that iron is a very useful material for lightning rods, as the effective energy of a flash of lightning is rapidly dissipated in iron.

"Absolute protection of the whole of a building could only be assured by enclosing the whole structure in a system of wirework—a contrivance, in fact, of the nature of a bird-cage. This should be well connected at various points to the earth, as nearly all buildings have gas and water pipes and other metallic conductors in their interiors which are likewise earthed. For structures intended for the manufacture of storage of gunpowder and other explosives, the adoption of this bird-cage protection would be justified on the score alone of public safety. Architectural considerations prevent the adoption of such a method in its entirety for ordinary buildings. There is no doubt, however, that practically perfect protection may be assured by a judicious modification of the existing practice of erecting single lightning rods, especially in the case of extensive and lofty buildings that project well above surrounding structures, or that stand isolated in the open country."

The old theory assumed that the electricity ran off through the rod, much as water through a pipe, and hence the effectiveness of a rod depended upon its electric conductivity. As a matter of fact the copper is too good a conductor, allowing the discharge to pass too quickly, producing a shock of much violence. An iron conductor offers more impedance to the current, and allows it to leak away by damping down the oscillations, so there is less chance of a side flash from an iron than from a copper conductor.

"The characteristics of a flash of lightning which more particularly concern us are:—(1) surging, that is due to the oscillatory character of the spark which, unlike the currents employed for conveying electricity to a distance for lighting cities or driving tramcars, is a disruptive discharge, sudden and violent, more like the blow of a hammer; (2); self-induction, a property which gives rise to counter force or choking effect, noticeable in straight wires, but which is much more pronounced in coils of wire; (3) side flash, the result of self-induction. A disruptive discharge will often leave what would ordinarily be called an excellent conductor and side flash through the air to other much wore conductors; for instance, the lightning rod may be struck, but instead of following the course provided, a side flash may select its own path through a wall of brick or stone to a neighbouring gas-pipe or bell-wire."

Side flashes may be sources of great danger, and iron or wire fences have been repeatedly observed to cause the deaths of live stock in this manner by lightning.

"The principal causes of the failure of the usual style of lightning-rod as fitted on the buildings investigated, appear to be due to the following: (1) insufficient number of conductor and earth connections; (2) the absence of any system of connecting the metallic portions of the buildings to the lightning conductor, especially the interconnection of the finials, rain-water pipes, and gutters. In the author's opinion the frequent damage by sideflash from the conductors might be lessened by running a horizontal conductor along the ridge or along the parapets of all the roofs, somewhat after the method which is almost universally adopted in Central Europe.

"The lightning strokes may be divided

into three classes:—(1) Those where the conductor conveyed a portion of the flash to other unearthed metallic conductors damaged the building; the practice of running the conductor round the projecting masonry, often taking sharp bends, doubtless facilitated the deviation of the current from its direct path to the earth; (2) in several observations a metallic roof of large area received the flash, consequently became highly charged, and the single conductor failed to convey the whole of the stroke, a portion of which took a circuitous path, for instance, through a speaking tube and an electric bell wire; (3) a flash struck the building at two points simultaneously, a lightning conductor taking one part of the stroke, but damage was caused by the other portion selecting an unprotected part of the roof."

Theoretically the best method of protecting a building is to enclose it in a sort of bird-cage of metallic conductors, properly earthed. This, of course, cannot be literally effected, but the principle can be carried out very closely without being made at all conspicuous or offensive. No general rules can be given, as each case must be arranged according to the special conditions. Vertical conductors should be run from the highest points to earth, with horizontal conductors along the ridges of the roof, connected to all salient ironwork, guttering, and rainwater pipes. The air terminals need not project much above the highest points, but great attention should be given to the grounding. An earth, to be of use, must be of low resistance, and that is only obtained in moist ground. If this is not easily obtained, the best way to keep the earth connection damp is to run a small pipe from the nearest rain-water pipe in such a manner that some of the rainfall is diverted directly to the metal plate.

THE EDUCATION OF RAILROAD EMPLOYEES.

METHODS OF PROVIDING TECHNICALLY TRAINED MEN FOR RESPONSIBLE POSITIONS IN RAILROAD SERVICE.

George M. Basford—Railway Master Mechanics' Association.

IN all departments of engineering work the necessity for providing men who shall not only be competent but also technically responsible, has become a pressing problem. Especially is it becoming so in railway work, owing to the tremendous growth in operations as compared with the simpler methods and smaller scope of work a few years back. In a paper presented by Mr. George M. Basford, before the American Railway Master Mechanics' Association, the question of the technical education of railroad employees is treated in an interesting manner, and some valuable suggestions advanced. The present condition of railway operation especially, is set forth in a manner which shows very clearly the need for men of ability, character, and training to hold responsible positions.

"It is no small task properly to direct the design, to operate and maintain a thousand or more traveling power stations, such as modern locomotives have become, and to build up a policy and an organisation sufficient for such an undertaking on a single road, let alone doing this for a combination of roads. No other class of men in the world—without exception—is ever called upon to do what is everywhere expected of motive power officers, and the demands increase continually. The problem has grown perceptibly in two years and enormously in five.

"The problem is the selection, preparation and training of men. If this is provided for the rest is easy. It is said to be less difficult to secure a new president than to secure a good shop or roundhouse foreman. This is, of course, not true, but it certainly is sufficiently difficult to obtain the necessary supply of foremen of the right sort and even more difficult to secure the right kind of men in the ranks. The men are not essentially different from those of a generation ago, but the conditions certainly are different. To improve conditions it is necessary to know what is wrong, and to know what is wrong it is necessary to understand the changes which the last few years have brought.

"A few years ago railroad mileage was

computed in hundreds, whereas now it is measured in tens of thousands. The general manager once knew all of his subordinate officials, because they were few and changes were not frequent. He once knew all of his master mechanics, station agents, conductors, engineers, despatchers and even telegraph operators. They knew him and were working for him because he was personally close to them in their work. All this has changed as the roads themselves became greater and as roads great in themselves combined into systems, as has never been done anywhere else in the world. With this change the officers have by a powerful current been carried far from the men in the ranks and far even from their subordinate officials. From personal friends, the men have become to them as mere numbers."

The question of the expansion of a railroad organization is compared to that of an army, and it is shown that military methods are such that the size of an aggregation of men need not affect its efficiency or its strength. The commanding officer of an army cannot know all his men, but the captains do know theirs, and from this standpoint the railroads need more captains, because the subordinate officers now know their men as little as the chiefs know their subordinate officers.

"The recruiting of shop forces in the past was through apprenticeship. It is not so to-day. One of the best equipped railroad boiler shops in the country has not a single apprentice and few of them have enough to be worth mentioning. Of twelve trades in one shop plant only three were found to have apprentices, but all had shop committees. In other departments apprenticeship has been overlooked and neglected because there was so much else to do. There has been too much pressure to turn out work with existing facilities to admit of taking the necessary precautions concerning the men and the leaders of the future. The present demand for foremen with leadership talent and executive possibilities proves both the neglect of the apprentice and the distance which has grown between the officers and the men, for there certainly must be latent talent, dormant and undiscovered, sufficient for all necessities."

Formerly the ideal method of recruiting was found in apprenticeship. Apprenticeship, however, takes time, and the present pace does not admit of the continuance of a system which demands years for the acquisition of knowledge, which, under different methods and with proper preparation, may be effected in a much shorter time in a far more effective manner.

"For twenty years the railroads have sought to provide the necessary leadership from the technical colleges, and many strong officers have developed through what is known as the special apprentice system. It is perhaps possible to meet the immediate need in some such way; but when the technical school graduates come to the railroads, as outsiders, from the schools—as they usually do—this system is doing a fundamental injury, which is neither understood nor appreciated, but it is nevertheless serious. Every time a special apprentice is started on his course notice is, in effect, served upon the men and boys with whom he works, that he, because of his education, is to acquire in a few years sufficient knowledge, experience and ability to become one of the official staff. The effect in the shop is to discourage those who have not had such education. The special training of young men from without the ranks of the workers, for official positions, is fundamentally wrong, and, furthermore, it plays strongly into the hands of those who wish to see men leveled into classes, and considered as on uniform levels, as to the value of service. It may be necessary to continue special apprenticeship for a time. Technically educated men are needed and will be needed even more in the future, but they should come from the ranks and not from outside of the service. The present system, or any other system, which in any way serves to discourage the regular apprentices and thereby tends to cut off the source from which most of the successful men have come should give place to a system which will encourage all by making it possible for the lowest to become the highest in the briefest possible time, because the talent is needed now. Nothing adequately meeting the needs of American railroads has been accomplished either here or abroad. That such a system is possible and feasible can now be shown."

The method suggested by Mr. Basford is that of a revival of the old apprenticeship method, with an important, or even radical modification. The boys should be given the training in the shop, under such competent direction as will increase their earning capacity to the utmost, and consequently their value to their employers; and parallel with this shop training, instruction in a school provided and maintained by the road should be required. The school and the shop should be co-ordinate in every possible way, and the local officers must be interested in and responsible for the boys in the school as well as in the shop.

"As a part of the plan, every roundhouse should have a comfortable reading-room, provided by the company, with books, periodicals, charts and models. Every encouragement should be given the engineers and firemen to organize improvement clubs. The company should furnish stereopticons and occasional lecturers. Progressive education should accompany the present tendency toward progressive examinations. Here is another opportunity for university extension. Engineers and firemen should be educated to do their best, and it is important to bear in mind the fact that the difference between the work of the best and of the average man represents more to the road than the economies to be obtained from the best fuel-saving appliance or invention ever brought out."

Of course there are practical difficulties in the way of this plan, as, indeed, of any which can be advanced. Probably the most serious one is that of obtaining suitable instructors, and it is true that competent men for this kind of work are not plentiful, nor can they be had without proper compensation. Another difficulty is that of securing to the shop which has done the training the fruits of its enterprise. The old seven years' indenture was devised, partly for the training of the apprentice and partly to secure to the master some reasonable share of the young man's services after he had been trained. We have seen of late many instances of railroads acquiring the valuable services of men trained by rival roads, and there is no reason to believe that similar methods would not obtain with the rank and file which have been used higher up.

IRRIGATION IN EGYPT.

PROPOSED METHODS OF EXTENDING THE SCOPE OF THE WORKS FOR THE REGULATION OF THE NILE FLOODS.

Engineering.

WE have reviewed at various times in these columns the important engineering works constructed by the British government for the control of the flood waters of the Nile and for the redemption of vast areas of arable land in Egypt. That these works are by no means complete, is well understood, and the problems which are involved in their extension demand the highest engineering skill and the exercise of judgment and tact as well, in order to avoid political, financial, and sentimental difficulties. In a leading article published in a recent issue of *Engineering* the present state of the question is clearly set forth, together with some suggestions as to the correct procedure are made.

"The land of Egypt is unique in its physical conditions, as in its history. The cultivable soil of the country owes its origin entirely to the accumulated deposits of silt brought down annually by the Nile when in flood, and left on the land by the receding waters. Owing to the absence of rainfall in Egypt, the soil is entirely dependent upon these annual inundations both for water and for fertilisation; and any variation in the height of the river from the normal may cause widespread distress, and even famine—from drought or floods. The danger of this has been recognised from the earliest times. The ancient Egyptians attacked the problem with such success that 4,000 years ago the valley of the Nile supported a dense population, whose monuments stand to the present day among the wonders of the world. A civilisation capable of erecting the pyramids would be equally able to conceive and carry out the more important works for controlling the irrigation of the country, though it is only during the last two decades that the magni-

tude and character of these works have been realised by the modern world. Diodorus, Strabo, and Herodotus have independently borne witness to a vast artificial lake or reservoir, which was constructed to receive the superflous water from the Nile at flood time, and to distribute it when and where required by means of canals. The latter writer is enthusiastic in his admiration of the work, which he classes far above the mighty Pyramid of Cheops as an example of the triumph of human skill and labour over natural obstacles. This lake—Moeris—was dug by the orders of King Amenemhat III., who lived about 2000 B.C. It had a superficial area of 950 square miles—about the size of an average English county—with a depth in places of 300 ft., and its contour measured 450 miles. It was connected to the Nile by a canal ten miles long and 300 ft. wide, controlled by means of sluices, which served to draw off the surplus water from the river, and return it at periods of low water.

"As all who have followed the recent history of Egypt will know, the site of the ancient lake has been identified beyond doubt with the present province known as the Fayoum, by Mr. Cope Whitehouse, whose researches have not only abundantly justified the classical historians, but have had a most direct bearing upon the problem of the irrigation of Egypt at the present day. The canal to the Nile had become silted up during centuries of neglect, and the lake had vanished, but the depression remained, as a fertile valley in the desert."

When, in recent years, the control of Egypt was undertaken by Western nations it was seen that one of the most important things to be done was the regulation of the Nile and the control of irrigation by the construction of proper irrigation works. Attempts were made to reconstruct the barrage built at the apex of the Delta by the French in 1861, but this was seen to be insufficient, and hence the great dam at Assouan was designed and built, together with the regulating barrage at Assiout. So much has been written about these important works during and since their construction that details of the work need not be given here. Of more immedjate interest is the answer to the question; what is next to be done? For it has become distinctly evident that these works, large and important though they are, are by no means adequate to accomplish the desired result. The irrigable area of Egypt is placed at six and a quarter million acres, and there is an ample supply of water in the Nile for the purpose, providing that the superfluous flood water is stored for use in the dry season. At the present time four million acres are perenially irrigated, and one-quarter of a million acres lying along the edge of the deserts must remain irrigated only in flood time, leaving the great area of two million acres yet to be dealt with. Since a storage capacity of two milliards of cubic metres of water are required for each million acres, so that the problem is that of providing reservoir capacity for four milliards of cubic metres of water. At its present level the reservoir formed by the dam at Assouan stores but one milliard of cubic metres, or only one-fourth of the required amount, leaving three milliards of cubic metres to be provided for.

In seeking for a reservoir for the supply of Egypt during the dry season, it is not to be wondered at that the reconstruction of the ancient Lake of Moeris should have been carefully considered. As, however, in the bed of the lake is a fertile province, with a cultivable area of 400,000 acres and a value of £80,000,000, its construction on its original site is out of the question; but there exists a smaller depression in the Libyan hills immediately to the south to which no such objections apply. This depression is known as the Wady Rayan, and Mr. Cope Whitehouse, the discoverer of Lake Moeris, has for years insisted that in turning the Wady Rayan into an artificial lake or reservoir lies the true solution of the problem of Egypt's water supply. Its area at a level of 29 metres above that of the sea would be about 700 square kilometres, or 270 square miles. When full, its greatest depth would be 70 metres, though only the upper four or five metres would be used annually, giving a possible supply of some three milliards of cubic metres out of a total contents of 20 milliards. Such a lake, however, would have one great drawback. Although during the month of April it would give a plentiful discharge, by the end of May its level would have so diminished that it could not give all that

Lower Egypt requires. By the middle of June it could not meet half the demand upon it for water, and a fortnight later it would be practically useless, as its level would have sunk approximately to that of the Nile. For this reason, by itself it would be inadequate, but, fortunately, we have at hand a means of contributing to the summer supply from another source. The Assouan reservoir, owing to its height, can be drawn from at any season of the year, and it is proposed by Sir W. Willcocks to raise the dam by six metres, making it the height originally intended, and use the water so stored to supplement the Wady Rayan discharge, thus maintaining a constant total discharge throughout the summer. The Assouan reservoir would, when raised, yield a supply of two milliards of cubic metres, and this would not be drawn upon until some time during May. As the summer came on the proportion of water from Assouan would increase, until in July it would be giving practically the whole supply. Working together in this manner the lake and the reservoir would provide the whole of the water needed for the irrigation of Egypt.

So far as the question of the strength of the dam is concerned, this has been agitated of late, especially in connection with the recent investigations of Messrs. Pearson and Atcherly, and the report of Sir Benjamin Baker. There appears to be little doubt that injurious scour has been produced upon the bed of the stream below the dam by the action of the discharge through the sluices, and for this reason, at least, the raising of the dam has been postponed.

The estimates of cost of the Wady Rayan scheme, according to Sir William Willcocks, amount to £2,600,000.

Mr. Cope Whitehouse, who first proposed the use of the Wady Rayan over twenty years ago, and who undoubtedly has a most intimate knowledge of the local topography, maintains that the entire work necessary can be done at a cost of £600,000. He has offered many times to undertake the contract for the work on the basis of this estimate, or to carry it out as a private speculation, subject to equitable terms of purchase by the Egyptian Government when completed. It is unfortunate that these offers had to be rejected, not because of any engineering reasons, but because the Government considered it preferable to leave a great part of Egypt unwatered rather than allow private enterprise to obtain command of any part of the national irrigation. However, whether it is to cost £600,000 or £2,600,000, the outlay will bring an enormous and immediate return, and the names of those who have assisted in bringing it to completion will deserve remembrance among the greatest benefactors of Egypt.

THE OSCILLATIONS OF RAILWAY VEHICLES.

CAUSES OF VIBRATION OF LOCOMOTIVES AND RAILWAY CARRIAGES AND METHODS OF REDUCING OSCILLATIONS.

Georges Marié—Académie des Sciences.

With the increasing demand for high speeds on railways it becomes necessary to investigate every possible cause of irregularity in motion, and perturbations which are negligible at moderate speeds may become of serious importance when trains are operated at rates of six to eighty miles an hour. Some of the causes of vibration in locomotives may undoubtedly be referred to the reciprocating parts of the engines, but there are other sources of irregularity. During the earlier experiments on the military railway between Marienfelde and Zossen, for example, much trouble was at first experienced from the oscillations of the cars, and yet these were driven by electric motors having only rotary movements, so that there was no reciprocating movement to be considered, and it was not until heavier rails and a more massive roadbed were provided that the higher speeds could be safely attained.

In papers recently presented before the French Academy by M. Georges Marié, and published in the *Comptes Rendus*, the various causes for the oscillation of railway vehicles are examined, and in view of

the interest at present felt in the operation of high speed trains, some abstract of these papers is deemed opportune.

The vibratory action of steam locomotives has been studied for many years, and in nearly all cases the forces developed by the inertia of the reciprocating parts are modified by placing counter weights in the driving wheels. It is well understood, however, that such means are but partially effective, and in fact no disposition of revolving weights can wholly balance the action of reciprocating forces. It is also to be considered that the effort of the steam upon the pistons varies greatly during each stroke, and these variations are added to those of the reciprocating weights to produce vibrations. When it is considered how a stationary engine, even of moderate size and running at a medium speed, is carefully secured to a massive foundation, the difference in the case of a locomotive developing more than a thousand horse power, supported upon elastic springs, and propelling itself over an uneven roadway at a rate of 100 feet a second, may be appreciated.

The introduction of the four-cylinder balanced compound locomotive has enabled the disturbing action of the reciprocating parts to be materially diminished, but these are not entirely eliminated. To them must also be added the influence of the conical form of the tires, and the action of the steam in the cylinders as has already been seen.

All these, however, are but origins of vibrations, and in well designed engines they may be controlled as to be kept within practical limits at moderate speeds. At high speeds, however, they may give rise to serious and even dangerous oscillations. Thus, by carefully balancing, the perturbation due to any action of the machinery may be kept very small, considered at any one time. The periodical repetition of such an action, however, may cause a continual increase in amplitude until oscillations powerful enough to cause derailment may be reached. It is this increase in the amplitude of the oscillations, with increase in speed which is so important, and to this matter M. Marié gives especial attention.

In the case of a locomotive engine there is a tendency to develop an oscillation about a vertical axis passing through the centre of gravity, together with a horizontal oscillation of translation, besides a balancing action about longitudinal and transverse horizontal axes. It is most undesirable to have a synchronism existing between the period of oscillation of the locomotive and the revolutions of the driving wheels. For very high speeds it appears that the period of oscillation corresponds to about three complete revolutions of the drivers, and the experiments of M. Marié have shown that an odd synchronous relation of this sort is especially unfavourable.

Apparently the principal preventive of an increase in the amplitude of the oscillations lies in the damping effect of the friction of the various parts, such as the plates of the springs, the lateral friction of the bogie truck and of the tires. Even with the highest speeds at present employed it does not appear that the oscillations reach an amplitude rendering derailment probable. M. Marié points out, however, that care must be taken not to allow the damping action of the frictional resistances to be reduced too much, or an increase in oscillation may follow. The lateral oscillations of a locomotive may act to cause gradual spreading of the rails, this being in itself a serious cause of accident, and on roads on which high speed trains are operated, an especially careful watch should be kept by the track inspectors to detect such spreading action.

M. Marié is of opinion that a locomotive engine should not be made too rigid, but should rather possess sufficient elasticity to yield slightly in any direction, while at the same time opposing sufficient frictional resistance to retard any vibration so as to destroy any periodicity which might otherwise exist and develop existing oscillations.

There is no doubt that the question of the oscillation of railway rolling stock is a matter demanding the closest study and attention. Although vibrations are the primary cause of such oscillations it is the oscillations themselves, multiplying and increasing the vibratory effect, which constitute the danger. The lateral movement of the locomotive upon the track, causing the conical form of the tires to add its influence, may, at high speeds become sufficiently great to exert a most destructive action upon the track, and while the friction produced will dampen the oscillations the repetition of

the action cannot fail to lead to disaster unless the effect is checked.

Railroad engineers have repeatedly maintained that the question of extremely high speeds is largely a matter of permanent way, and that with a sufficiently heavy track, well laid, and free from heavy grades and sharp curves, any reasonable speed may be maintained with existing locomotives. To this should be added the necessity of the closest inspection of the roadbed at all times, an especial watch being maintained to detect the particular deformations which may result from the repeated oscillations.

THE INFLUENCE OF STEAM JACKETS.

AN INVESTIGATION TO DETERMINE THE EFFECTS OF STEAM JACKETING UPON THE EFFICIENCY OF A HORIZONTAL COMPOUND STEAM ENGINE.

A. L. Mellanby—Institution of Mechanical Engineers.

NOTWITHSTANDING the numerous experiments which have been made to determine the influence of steam jackets upon steam-engine performance there still exists a difference of opinion among engineers, and the question is by no means yet regarded as settled. For this reason every intelligent investigation upon the actual behaviour of steam jackets is to be welcomed as aiding to determine a question of practical value. If there is little or no gain in the use of the jacket it should certainly be omitted, otherwise a needless cost and complication is added to the machine, but if there is any real advantage or economy to be effected by its use the jacket may well be retained. In a paper presented at the Liége meeting of the Institution of Mechanical Engineers by Mr. A. L. Mellanby some recent experiments made upon steam jackets at the Manchester Municipal School of Technology are described and discussed, and some points of interest brought out. Referring to previous investigations upon the same subject, Mr. Mellanby says that opinion has become somewhat settled on the following lines:

"(1) That jackets are useful for slow revolution, but not for quick-revolution engines.

"(2) That jackets are useful for simple and compound engines, but that their efficiency is doubtful, if they are applied to triple or quadruple expansion engines.

"It has long been obvious that there was considerable room for further experimental research upon this subject. The author therefore determined to take advantage of the opportunity which he had of carrying out tests upon the experimental engine at the Manchester School of Technology, to see whether some definite knowledge upon this important point could not be obtained.

"In most of the tests that have been published, it has been the custom to run a trial on any available engine that was fitted with jackets, and to find out the water used per indicated horse power per hour. This water would include the amount that entered the cylinder, and the amount that was condensed in the jackets. Another trial would then be made with the jackets shut off, and the consumption per indicated horse power per hour again measured. In some cases it has happened that the jacket steam has had the effect of reducing the engine-feed or increasing the horse power, and so improving the economy. In other cases it has happened that any reduced engine-feed or increased horse power has been more than counterbalanced by the extra steam used in the jackets. In the majority of the experiments published, the jacketed and unjacketed trials have been run at the same load, and no attempt has been made to find the best conditions for either case. The chief reason for this has been that the engines experimented upon were in actual service, and their load was fixed by the amount of work they had to do and not with regard to their best performance. Comparisons from such trials are of little scientific value, as it might easily happen if an engine were working at its most economical load for the jacketed conditions, the same would not be the most suitable when the jackets were off."

The engine upon which the tests were made was a horizontal cross-compound engine, 11½ inches by 20 inches by 36 inches

stroke, the high-pressure cylinder being fitted with Corliss valves and the low-pressure cylinder with slide valves and Meyer cut-off plates. Both cylinders were jacketed on sides and heads, with separate supply pipes and valves, enabling either sides or heads to be cut out. The condensed jacket steam was drained off and measured in separate calibrated vessels. Full details and logs of the tests are given in the original paper, and the results graphically plotted in curves and tabulated for reference.

The effects of the jackets upon the performance of the engine are considered upon the power developed, and upon the steam consumption.

The use of jackets upon the high-pressure cylinder has the general effect of decreasing the mean effective pressure, and hence diminishing the horse power. The jacketing of the low-pressure cylinder has a different effect. The release pressure in the high-pressure cylinder is diminished to a slight extent, but the high-pressure back-pressure and the low-pressure admission-pressure are considerably increased. The low-pressure jackets therefore slightly lessen the steam in the high-pressure cylinder but to increase that passing through the low-pressure cylinder.

So far as steam consumption is concerned, the application of the jackets seems, as a general rule, to reduce the amount of steam passing through the cylinder of the engine. With only the high-pressure jackets on, the total steam per hour, namely, air-pump discharge and jacket steam, is less than when the engine is unjacketed. When the low-pressure jackets are applied, although the air-pump discharge is lessened, the total steam used is increased.

Mr. Mellanby gives especial attention to the so-called "missing quantity," or the difference between the indicated and the actual weight of steam passing through the cylinder. The experiments show that the indicated weight at release is in all cases greater than that at cut-off; that is, the missing quantity is less, or there is more steam shown to be present in the cylinder by the indicator at release than at cut-off.

"From an inspection of the curves of consumption, it would appear that if one wished to improve the economy of an engine, one ought to aim at reducing the missing quantity. In order to reduce this loss one ought to have a clear idea as to its cause, so that it may be known how best to apply the remedy. The necessity for a true explanation of this source of loss has long been obvious, and various theories have been brought forward by different writers and experimenters. The most commonly accepted explanation is that the cylinder walls are cooled by the out-going exhaust steam, that the incoming steam on meeting these cold walls is immediately condensed and fresh steam then passes in to supply the place of that condensed. A careful inspection of most text books reveals the fact, that it is the general opinion that the temperature of the cylinder walls follows that of the steam, and that at the end of release the walls are cooled down to the exhaust temperature. However, Professor Cotterill has pointed out that, if this were true, the missing quantity would be much greater than it usually is. He therefore inferred that the temperature range of the metal was less than that of the steam, and suggested that although the maximum temperature of the metal and steam would be probably the same, yet the minimum temperature of the metal was higher than that of the steam."

In investigating this same problem Messrs. Callendar and Nicolson showed that only a small proportion of the missing quantity was due to condensation, and they suggested that the greater part of the missing steam was due to direct leakage past the slide valve into the exhaust pipe. The steam jacket has an important influence upon this action as well as upon cylinder condensation, reducing the leakage as well as the condensation, this also agreeing with the experiments of Callendar and Nicolson.

There appears to be little doubt that the work of all recent experimenters on the steam engine demonstrates the presence of valve leakage to an important degree, and this point, as the principal source of loss in reciprocating engines, demands the attention of builders and designers alike both as to the type of valve adopted and the care given to its construction.

The following summary of results will be found of interest as containing the salient features of the researches of Mr. Mellanby:

(1) *Best mean pressure.*—That compound engines with a boiler pressure of 150 lbs. may be worked with a mean pressure referred to the low-pressure cylinder of about 40 lbs. per square inch without any loss of efficiency in terms of the brake horse-power.

(2) *Maximum efficiency.*—That the jackets have their maximum efficiency when the whole of the high-pressure and the ends of the low-pressure cylinders are jacketed with high-pressure steam.

(3) *Variation of indicated horse-power.*—That when the jackets are applied to the high-pressure cylinder the total indicated horse-power is slightly reduced, but when applied to the low-pressure cylinder the total indicated horse-power is considerably increased.

(4) *Initial condensation.* — That the jackets have little effect in the high-pressure but have a considerable effect in the low-pressure cylinder upon initial condensation.

(5) *Temperature-cycle of metal.*—That the temperature-cycle of the cylinder walls next to the steam must be considerably less than that of the steam.

(*a*) Because the actual missing quantity is much less than it would have been had the steam and metal gone through the same temperature changes.

(*b*) Because the mean temperature of the metal is higher than that of the steam.

(6) *Missing quantity.*—That the greater part of the 'missing quantity' must be due to leakage and not to initial condensation.

(*a*) Because the application of the methods suggested by Callendar and Nicolson shows the condensation to be but a small fraction of the total missing quantity.

(*b*) Because the apparent re-evaporation during expansion is less for jacketed than for unjacketed engines.

THE HEATING VALUE OF FUELS.

CALORIMETRIC METHODS FOR DETERMINING THE HEAT EVOLVED BY THE COMBUSTION OF ORGANIC SUBSTANCES.

H. Berthelot—Académie des Sciences.

THE term calorimeter has unfortunately been applied to several entirely different objects in connection with engineering work, and sometimes it is possible to determine which is meant only by a careful examination of the context. The old usage of the word to mean the collective sectional area of the flues in a boiler, is happily almost obsolete; but the use of the word to mean both an apparatus for determining the heating value of a fuel and a device for measuring the percentage of moisture in steam seem, unfortunately, to be too firmly established to permit of a change. The former use of the word is certainly the most logical, and it is of the fuel calorimeter that M. Berthelot speaks in a paper presented by him to the French Academy from which we make some abstract. The actual systematization of the method of measuring the calorific power of fuels was largely due to the work of M. Berthelot himself, he having demonstrated, as long ago as 1865, that the thermal value of a substance could be accurately computed from the heating power of its constituents, and hence his review of the subject, in a recent issue of *Comptes Rendus* possesses an especial value.

The earliest attempts to measure the heat value of a combustible were made by Lavoisier, who burned the substance in an atmosphere of oxygen, under atmospheric pressure, and from these crude experiments followed the work of Dulong, Andrews, Favre and Silbermann, and their successors. Experience has shown, however, that the direct combustion in this manner is accompanied with many difficulties, owing to the impracticability of insuring complete combustion, and the uncertainties in the determination of weights and temperatures. Various delicate corrections are necessary in order to eliminate error, so that there

are many opportunities for the precision of the result to be impaired.

M. Berthelot examines at length the extensive investigations which have been made by Thomsen, using the old method of combustion at atmospheric pressure, and shows that with all the care and ability which this able experimenter has brought to the work the results are in serious error in several instances. This being the case, it is hardly to be expected that the method can be found of practical utility in the hands of ordinary operators.

In order to avoid the errors which appear to be inseparably connected with the earlier methods, M. Berthelot devised the so-called calorimetric bomb, and with this apparatus he has succeeded in eliminating the principal sources of error. The fundamental principle involved in the bomb is that integral transformation of the substance shall be completely and definitely effected in an almost instantaneous manner, entirely within the calorimeter, thus reducing all the corrections to an extremely small fraction of the total heat measured. By employing pure oxygen under a high pressure this result has been accomplished, the ignition being effected by electricity, and the whole operation completed in the shortest possible time.

Insisting upon the necessity for eliminating the serious sources of error which creep in when the combustion is conducted for a considerable length of time, and at or near atmospheric pressure, M. Berthelot criticises rather severely the work of Thomsen, being moved thereto, doubtless by some recent comments of the German savant upon the results obtained by investigations in France. Regardless of any question of personal feeling in the matter, there appears to be little doubt of the superiority of the method devised by Berthelot, and modified by Mahler and others only in the direction of reduction of cost and increase in convenience, without material modification in principle. Engineers have learned very definitely that complete combustion can be promptly effected under pressure, while it is exceedingly difficult to insure the entire combustion of a determinate quantity of a fuel, even in the presence of oxygen, at atmospheric pressure. The time element is also an important one, and any quantitative method depending upon precise readings of delicate thermometers before and after a combustion, must certainly have the possibility of error greatly minimised by a reduction in the time of the whole operation.

It is interesting to note that in the recent tests of the heating values of American coals, made at the St. Louis Exposition under the auspices of the United States Geological Survey, the calorific values were determined by the Mahler bomb calorimeter, this being identical with the Berthelot calorimeter in principle and action, the modifications in design being made solely for the purpose of reducing the cost.

HIGH-SPEED ELECTRIC TRACTION.

A REVIEW OF THE WORK OF THE RESEARCH COMMITTEE UPON THE MARIENFELDE-ZOSSEN ELECTRIC RAILWAY.

Charles A. Mudge—New York Electrical Society.

WE have reviewed at length in these pages the remarkable results which have been attained with electric traction upon the military railway between Marienfelde and Zossen, near Berlin, and a fully illustrated paper upon the subject by Dr. Alfred Gradenwitz has also been published in this magazine. Since those experiments the work of investigation has been continued by a special research committee, and much interesting information has been gained about high-speed electric traction, as well as high railway speeds in general. In the course of a lecture delivered before the New York Electrical Society, Mr. Charles A. Mudge, who has taken part in some of these tests, discussed the work which has thus far been done, and an abstract of these valuable investigations is here given from this address:

"The objects of the tests were to make a study of many of the heretofore incompletely, and in some cases, wholly unknown factors entering into electric traction at speeds never before attempted, such as col-

lecting current at high voltages, traction and air resistances, best design of trolleys, motors, transformers, brake gears and trucks, the power required to run at high speeds, the details entering into the construction of the permanent way and the collection of other data in order to calculate costs of future installations."

The construction of the road and the rolling stock has already been fully described, and it is necessary here only to repeat that the road is about fourteen and a half miles long, with but two curves, each of one and a quarter miles' radius, there being no grades. Allowing four miles at each end for acceleration, there remained a run of seven miles upon which the actual high-speed runs were made. The power was supplied in the form of three-phase current at about 14,000 volts in the car, the car weighing about 100 tons complete, and during the high-speed tests it was successfully run at speeds of 125 to 131 miles per hour. Among the important elements investigated by the research committee were those involving train resistance at different loads and speeds and the necessary data for use in braking. Investigations upon air resistance were also made, and valuable data determined. Referring to the earlier trials, in the autumn of 1902, Mr. Mudge said:

"These tests were conducted up to a speed of only seventy-five miles per hour, as the observations of the previous year showed that the permanent way would not stand much higher speeds. To determine the train resistance as well as the energy absorbed in running the car a distance of four miles, starting at the car barn, was very carefully measured, and all curves, grades and levels were absolutely fixed. This made it possible to correct the observed data so accurately that the recorded results in this year's report are of the greatest value.

"The brake tests made in this year were not as satisfactory as those in the following year, on account of the complicated brake rigging used, which did not allow of easy adjustment, and which I will not therefore attempt to analyze.

"Suffice to say, that the maximum retardation of two miles per hour per second was recorded at seventy miles per hour, with a total brake pressure equal to 155 per cent. of the weight of the car. At the conclusion of the tests this year it was found necessary to build new trucks with a two-foot longer wheel base, and to support the car body on the truck frame at some distance from the centre pin. Also to flexibly support the centre pin in the truck, thereby allowing the car body to have a movement of about one inch on each side of the truck centre independent of it, and in a line at right angles to the track. In order to observe the action of the springs and their connecting levers, it was decided to place them on the outside of the frame of the truck. The tests this year were of value in showing what alterations in the car and permanent way were necessary in order to be able to run at higher speeds.

"Data of very great value were secured on the much discussed question of air resistance, and although the formula may not be straightened out to suit everybody, we know positively that if we run our car, for instance, fifty miles per hour we can expect a maxmum air pressure of about seven pounds per square foot at the front of it; and if we double the speed we will get four times this pressure, and if we triple the speed we will run into trouble and get nine times this pressure. If we shape the nose of our car properly we will be able to reduce these figures ten per cent. Also if we run our 100-ton car fifty miles per hour on a level track without paying much attention how the front of it is shaped, it will take about 150 horse-power. When we double the speed it will take six times this amount of power; but if we attempt to triple the speed, i. e., to run at 150 miles per hour, we would have to supply about eighteen times the amount of power it takes to run at fifty miles per hour."

It is well known that an important element in successful high-speed operation on steam railways is the character and condition of the track and roadbed. In view of the absence of reciprocating parts in the electric machinery on the cars it might be supposed that an extremely heavy track would not be as essential with electric traction as with steam locomotives. It was found, however, that much of the vibration and oscillation was due to the roadbed, and this was made a point for study. In addition it was thought advisable to use improved trucks with greater wheel base. The

experiments made after these improvements were carried out showed very satisfactory results. This was due, not only to the better designed trucks, but also to the excellent service given by the new track, consisting of rails of 82½ pounds weight, with closer spaced cross ties, and more substantial ballast. With the lighter track there was a marked oscillation produced when it was attempted to run the car faster than 100 miles an hour, a swinging lateral motion being produced which threatened to endanger the overhead work. This was found to be due to the unsymmetrical disposition of the motors and transformers on the car, and it was counteracted by placing weights along the floor of the car, in such positions as to oppose the periodic oscillation.

So far as braking is concerned, it has been found that very high brake pressures are required to give a comparatively low retardation. Thus, it was found that about seven-eighths of a mile was required to stop the car when running at 110 miles an hour, the initial brake pressure being 150 per cent. of the weight of the car.

"Basing our ideas upon some of the observations and experiences gained in these tests, we would make use of the following points in approaching a similar railway problem:

"Keep the car body as near the rails as possible.

"Arrange all heavy pieces of apparatus so that their centres of gravity lie in the centre of the car, or symmetrically placed to it, and as near the earth as possible.

"All apparatus mounted above the car floor should be as light as their design will permit.

"Make the overhead trolley contact above the car, in preference to the side of the car.

"Support the motors flexibly on the axles of the trucks.

"Give the front end of the car a wedge shape.

"Support the car body to the truck frame at some distance from the centre bolt, and allow it a flexibility in a line at right angles to the track, independent of the truck.

"Make the total wheel base of the truck of ample dimensions, and not less than twenty per cent. of the length of the car.

"Build the road as straight as possible, and where more than one track is used make them further apart than our present practice would suggest.

"On curves, make the approaches of the elevated side of the track longer than usual.

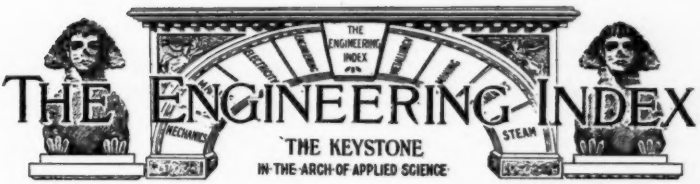
"In providing for curves at these high speeds it has been found important to allow the car body to be permited a certain amount of lateral movement on the trucks. The trucks take curves much more quickly than the heavy car body, and a certain amount of time is required to swing it out of its straight-line path. By mounting the centre-pin bearing flexibly in the truck the car body is swung more gradually into the direction taken by the trucks, and the shock is materially lessened.

"The question of signalling high-speed trains is a matter demanding serious consideration.

"In passing stations at 125 miles per hour it was not possible to recognize persons standing upon the platforms, and only those at a distance of fifty feet and over could be approximately identified. On dark and rainy days it was quite impossible to read signals at this speed, except when of large dimensions or of very pronounced color.

"This would suggest placing the signals in the car itself, operated electrically, either by direct contact or through inductive means. Such a system was tried at Zossen and worked perfectly, even at the highest speeds.

"In all the runs, of which over 300 were made, no difficulties were met with, or even suggested, that the skill of the engineer did not or could not overcome, and this great triumph, in a branch of industry which has done more than any other to lift the human race to a higher degree of intelligence, should serve as a stimulus to us, who are anxious to have trains in regular service running at this, the highest speed ever attained by any device used for human transportation, 131 miles an hour."



The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Austerlitz.

The Double-Track Austerlitz Bridge, Paris. Illustrated description of an arch bridge across the Seine, with a suspended floor of peculiar construction. 2200 w. Eng Rec—June 24, 1905. No. 70385.

Cantilever.

The Cantilever Erection of the St. Joseph Drawbridge. An illustrated account of this work, with an explanation of the difficulties encountered in erecting the east arm of the draw span. 1500 w. Eng Rec—June 3, 1905. No. 70058.

Concrete Arch.

The Connecticut Avenue Concrete Arch Bridge at Washington, D. C. Illustrated description of the structure and methods of construction. 3000 w. Eng News—June 1, 1905. No. 70038.

Concrete.

Concrete Bridge Over the Big Muddy

We supply copies of these articles. See page 797.

River, Illinois Central Railroad. Illustrated detailed description of the new bridge at Carbondale, Ill., consisting of three elliptical arches, and built almost entirely of concrete. 1800 w. Sci Am Sup—June 17, 1905. No. 70242.

Draw-Bridge Wreck.

Wreck of the Portage Canal Draw-Bridge. A detailed account of the accident at Houghton, Mich., with illustrations, and of the clearing of the channel. 1000 w. Eng News—June 1, 1905. No. 70042.

Floors.

Ballasted Bridge Floors. A. F. Robinson. Gives illustrations and information of work in Great Britain and America, with remarks on the various types. General discussion follows. 14000 w. Jour W Soc of Engs—June, 1905. No. 70526 D.

Fraser River.

The New Westminister Bridge Over the Fraser River, British Columbia. Illustrated detailed description of this double-deck railway and highway structure, and its construction. 2500 w. Eng News—June 15, 1905. No. 70234.

The New Westminster Bridge Over the Fraser River, British Columbia. Illustrates and describes the superstructure, notable for the special "spread" span designed to accommodate a Y-track, and for the methods of erection. 2000 w. Eng News—June 22, 1905. No. 70346.

Highway Bridge.

The Highway Bridge Over the Wabash River at Terre Haute. Illustrated description of a structure having an unusual combination of trusses and plate girders. 2000 w. Eng Rec—June 17, 1905. No. 70291.

Nile.

The New Bridge over the Nile at Cairo (Die Neuen Nilbrücken in Kairo) Josef Rosshändler. Discussing the plans for the proposed highway bridge, with details of the various projects submitted. 2500 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—May 26, 1905. No. 70443 D.

Plate Girder.

Plate Girder Bridge with Pile Bents. G. S. Crites. Illustrates and describes a design used on the Southern Pacific in certain places, which seems to eliminate the danger of blocking streams, and fills all demands. 1500 w. Cal Jour of Tech —May, 1905. No. 70325 C.

Reinforced Concrete.

Grand River Reinforced Concrete Bridge, Grand Rapids, Mich. Information concerning the design and construction as given in a paper before the Michigan Engng. Soc., by P. M. Louwerse. 1200 w. Eng Rec—June 17, 1905. No. 70293.

Swing Bridge.

The St. Louis Southwestern Bridge at Shreveport, La. Illustrated detailed description of a bridge with swing span, the total length of the bridge being 1265 ft. 800 w. R R Gaz—Vol. XXXVIII., No. 24. No. 70265.

Thebes.

The Thebes Bridge. Ralph Mojeski. An illustrated description of the location, design, and construction, discussing the considerations which led to the design as adopted. 6000 w. Trans Assn of Civ Eng of Cornell Univ—1905. No. 70538 F.

Transporter.

Widnes and Runcorn Transporter Bridge. Illustrated description of the bridge and its operation. 1300 w. Elec Engr, Lond—June 16, 1905. No. 70503 A.

Viaducts.

Caledonian Railway New Viaducts and Extensions. Illustrates and describes engineering features of interest, especially the erection of two viaducts over the river Avon, one of which is 175 feet above the bed of the river. 2800 w. Engr, Lond—June 9, 1905. No. 70310 A.

Reconstruction of the Horse Run Viaduct: Cincinnati Southern Railway. Illustrated description of the rebuilding, without interrupting traffic, of this bridge at Ludlow, Ky. 2000 w. Eng News—June 8, 1905. No. 70100.

The Fades Viaduct Over the Sioule River near Vauriat, France. Illustrated description of a continuous structure, a three-span girder of deck type, having two multiple-web trusses. The center is 435 ft. above the bed of the river, and masonry piers are used instead of steel towers. 1800 w. Eng News—June 8, 1905. No. 70094.

The Syra Valley Bridge at Plauen (in Vogtland). Herr Fleck. Illustrated detailed description of this stone viaduct. The arch has a span of 295 feet between abutments. 2700 w. Trans Assn of Civ Engrs of Cornell Univ—1905. No. 70542 F.

Zambezi.

The Bridge over the Zambezi (Le Pont sur le Zambéze). A description of the Falls of the Zambezi and the construction of the railway bridge over the gorge below the falls. 1500 w. Génie Civil—June 3, 1905. No. 70426 D.

CONSTRUCTION.

Arch Roof.

Three-Hinged Arch Roof of the New 69th Regiment Armory, New York City. Gives drawings of the framing, with description. 2000 w. Eng News—June 1, 1905. No. 70037.

We supply copies of these articles. See page 797.

Armory.

The Sixty-ninth Regiment Armory Drill Hall, New York. Illustrated detailed description of a fine drill hall 201 ft. 11½ in. long and about 188 ft. 10 in. wide, and nearly 130 feet in extreme height. 3900 w. Eng Rec—June 3, 1905. No. 70053.

Beams.

Notes on the Strength of Beams, Plates and Columns. R. P. King. An explanation of a method using the moment of resistance. 1500 w. Mach, N Y—June, 1905. No. 70003 C.

Buckling.

Tests upon the Buckling Resistance of Pillars with Fixed Ends (Ergebnisse von Versuchen über die Knickfestigkeit von Säulen mit Fest Eingespannten Enden). Prof. B. Kirseh. Data and tabulated results of tests upon round pillars of wrought iron under longitudinal pressure. 4000 w. Zeitschr d Ver Deutscher Ing—June 3, 1905. No. 70408 D.

Building Construction.

The Candler Building, Atlanta. Illustrated detailed description of a 17-story steel-cage office building. 1500 w. Eng Rec—June 17, 1905. No. 70296.

The Mutual Life Building in the City of Mexico. Brief illustrated description of a modern office building costing $1,500,000. The treacherous soil made it necessary to float the building on a mattrass of concrete and steel grillages. 1500 w. Eng Rec—June 10, 1905. No. 70182.

The Rebuilding of a Theatre at Buenos Ayres (Reconstruction d'un Theatre à Buenos Ayres). An illustrated account of the manner in which a large theatre was wholly rebuilt without interrupting the daily performances. 1000 w. Génie Civil—May 13, 1905. No. 70420 D.

Chimneys.

Chimney Shafts. An illustrated article discussing the repair, straightening, raising and felling of chimneys. 2200 w. Public Works—April, 1905. No. 69930 F.

Columns.

Results of Comparative Tests of Plain and Reinforced Concrete Columns. E. J. McCaustland. A record of tests made to determine the behavior of concrete and steel in combination. 1200 w. Eng News—June 15, 1905. No. 70235.

Concrete.

Description of the Concrete Residence at Port Antonio, Jamaica Islands. E. S. Larned. Ills. Also gives particulars of the construction. 2500 w. Cement Age—June, 1905. No. 70388.

Dams.

Masonry Dam for the Granite Springs Reservoir, Cheyenne, Wyo. A. J. Wiley. An illustrated article explaining conditions at Cheyenne, and describing this dam and the methods of construction and appliances. 4800 w. Eng Rec—June 24, 1905. No. 70378.

Masonry Dam for the Granite Springs Reservoir, Cheyenne Water-Works. A. J. Wiley. Slightly condensed from the author's report to the city of Cheyenne, Wyo. Illustrated detailed description of this dam, the methods of construction, and conditions. 5500 w. Eng News—June 29, 1905. No. 70536.

Memorandum *in re* Arched Concrete Dam at Barossa, South Australia. Alex. B. Moncrieff. An illustrated article especially dealing with the details of the concrete used in the construction. 2500 w. Trans Assn of Civ Engrs of Cornell Univ—1905. No. 70544 F.

The Assuan Dam. Reports an interview with Sir William Willcocks, discussing the difficulties due to erosion, and other matters relating to the design. 1200 w. Engr Lond—June 9, 1905. No. 70311 A.

Dry Docks.

See Marine Engineering.

Fire Protection.

Fire Protecting Coverings for Window and Door Openings. Abstract of a committee report presented at meeting of the Nat. Fire Pro. Assn. Opinions in regard to materials in use, with suggestions. 1000 w. Eng News—June 1, 1905. No. 70039.

Specifications for the Construction of Inside Oil Rooms. Report to the Nat. Fire Pro. Assn. concerning rooms for holding the daily supply of oils, paints, varnishes, etc. 1200 w. Eng News—June 1, 1905. No. 70040.

Hippodrome.

The New York Hippodrome. Harry D. Gue. Discusses the structural and protective features of this large amusement building. 2000 w. Ins Engng—June, 1905. No. 70320 C.

Inverted Siphon.

The Morris Canal Crossing of the Lackawanna R. R. Brief illustrated description of the unusual methods adopted to maintain traffic in the canal during the work of depressing the tracks of this road, and the building of an inverted siphon. 1100 w. Eng Rec—June 17, 1905. No. 70295.

Masonry.

Notes on Stone Masonry. Charles Arthur Hague. A discussion of stone masonry work and methods of adjusting cost and conditions. 2500 w. Cassier's Mag—June, 1905. No. 69968 B.

Reconstruction.

The Reconstruction of the Continental

We supply copies of these articles. See page 797.

Trust Building, Baltimore. Describes this sixteen-story steel-cage office building as first constructed, the damage wrought by the great fire, and the method and extent of reconstruction. Ills. 2500 w. Eng Rec—June 3, 1905. No. 70056.

Reinforced Concrete.

Expansion and Contraction Cracks in a Reinforced-Concrete Structure. George W. Blodgett. Detailed description of the buildings of the United Shoe Machinery Co., at Beverly, Mass., with report of the cracks, especially in the floors, and the method of making repairs. Ills. 2200 w. R R Gaz—Vol. XXXVIII., No. 24. No. 70262.

Reinforced Concrete Warehouse for North-west Knitting Co., Minneapolis, Minn. Drawings and description of building with novel features. 900 w. Eng News—June 8, 1905. No. 70098.

Reinforced Concrete Stable. Illustration and brief description of a stable at Scarsdale, N. Y. 1500 w. Eng Rec—June 10, 1905. No. 70181.

The Harrison Building. Cliff M. Stegner. Illustrated description of an eight story reinforced concrete skeleton building being erected in Cincinnati, O. 3000 w. Trans Assn of Civ Engrs of Cornell Univ—1905. No. 70546 F.

See also Civil Engineering, Bridges, and Materials of Construction.

Simplon.

The Simplon Tunnel. Lewis A. Parsons. Brief review of the work. 2000 w. Yale Sci M—June, 1905. No. 70299 C.

Warehouse.

The Ryerson Structural Steel Warehouse. Illustrated description of the enlarged plant on Sixteenth street, Chicago. 2000 w. Ir Age—June 1, 1905. No. 69959.

Wharf.

See Civil Engineering, Waterways and Harbors.

MATERIALS OF CONSTRUCTION.

Asphalt.

Asphalt and Bituminous Rock Deposits of the United States. Abstract by Prof. Arthur Lakes, from the U. S. Geological Survey. Describes the nature of the material and forms of veins. Ills. 3300 w. Mines & Min—June, 1905. No. 70077 C.

Brick.

Silica Coke-Oven Brick. Discusses their action on heating and cooling, comparing their wearing and heat-resisting qualities with those of clay brick. 1600 w. Mines & Min—June, 1905. No. 70078 C.

Building Stone.

Stone Quarries on the Coast. Report of H. Carmichael concerning the large quantities of good building stone along the coast and islands of British Columbia. 2000 w. B C Min Rec—May, 1905. No. 69956 B.

Tests on Texas Building Stones. William B. Phillips. Gives results of experiments with certain building stones of Texas, carried out by the University of Texas Mineral Survey, during the last two years. Ills. 3500 w. Min Wld—June 24, 1905. No. 70369.

Cement.

Tests of Cement at the Watertown Arsenal. James E. Howard. A report covering tests made during the past four years. 4800 w. Cement Age—June, 1905. No. 70390.

The Cement Resources of Alabama. Samuel H. Lea. Reports an almost inexhaustible supply of materials suitable for Portland cement, discussing the economic advantages they possess. Map. 2500 w. Mines & Min—June, 1905. No. 70076 C.

The Grinding of Portland Cement. George M. Newcomer. A study of the problem of grinding. 4500 w. Cement Age—June, 1905. No. 70389.

Concrete.

Some Recent Tests of Concrete in Tension and Compression at the Columbia University Laboratories. Ira H. Woolson. Gives results of tests made for the Astoria Light, Heat & Power Co. Ills. 3500 w. Eng News—June 1, 1905. No. 70036.

The Strength of Concrete. Sanford E. Thompson. A study of the practical tests that have been made on plain concrete and the laws that seem to govern the strength, giving much information of value. General discussion. 15800 w. Jour Assn of Engng Soc's—April, 1905. No. 70532 C.

See also Reinforced Concrete, below.

See also Civil Engineering, Construction.

Lime.

The Use of Hydrated Lime. Explanation of the properties of hydrated lime, as given in a paper by E. W. Lazell, before the Nat. Lime Mfrs. Assn. 1600 w. Eng Rec—June 3, 1905. No. 70059.

Reinforced Concrete.

The Frictional Resistance of Iron in Concrete (Versuche über den Gleitwiderstand Einbetonierten Eisens). C. Bach. Data and results of tests to determine the force required to cause reinforcing rods of various sections to slip in concrete mass. 1200 w. Zeitschr d Ver Deutscher Ing—June 3, 1905. No. 70412 D.

The Strength of Reinforced Concrete. T. L. Condron. A comparative study of

recent scientifically conducted tests of reinforced concrete beams. Discussion. 10800 w. Jour W Soc of Engrs—June, 1905. No. 70529 D.

See also Railway Engineering, Permanent Way and Buildings.

Sand.

The White Sands of New Mexico. Frank W. Brady. An illustrated description of a remarkable formation of nearly pure gypsum sand. 2000 w. Mines & Min—June, 1905. No. 70075 C.

Stone Work.

Decay and Preservation of Stone-Work. W. R. Purchase. Remarks on the causes of decay and what may be done toward diminishing their effects. 2500 w. Builder—June 17, 1905. Serial. 1st part. No. 70395 A.

Timber Preservation.

The Preservation of Timber with Antiseptics. E. H. Bowser. An explanation of the methods in use, especially the present method of creosoting as applied in the United States. 5000 w. Jour Assn of Engng Soc's—April, 1905. No. 70531 C.

MUNICIPAL.

Florence.

The Public Works of Florence. Cav. A. G. Linari. A brief review of municipal engineering in Florence, where great improvements have been made in recent years. 4000 w. Public Works—April, 1905. No. 69931 F.

Manila.

Present and Prospective Sanitation of Manila. O. L. Ingalls. An account of the method of waste disposal previous to American occupation and description of the sewerage system installed. 3000 w. Trans Assn of Civ Engrs of Cornell Univ—1905. No. 70547 F.

Parks.

The Park System of Metropolitan Boston. William T. Pierce. An illustrated article outlining the work of the Metropolitan Park Commission. Also some of the local and district parks are considered. 5800 w. Public Works—April, 1905. No. 69926 F.

Pavements.

Brick Pavement Specifications. Gives a specification designed to carry out the ideas of the writer, with remarks. 1600 w. Munic Engng—June, 1905. No. 69987 C.

Sewage.

Extensions of the Worcester Sewage Disposal Works. Illustrates and describes these works, which are the largest in the United States, and probably marked by the greatest variety of methods. The sewage is of peculiar character due to the presence of iron salts from wire mills. 2500 w. Eng Rec—June 24, 1905. No 70383.

Sewage Disposal Works at Chichester. James Saunders. Gives the early history of early sanitary conditions in this old Roman city and an illustrated description of the new sewage disposal works. 3500 w. Public Works—April, 1905. No. 69928 F.

Sewage Purification Plant at Charlotte, N. C. Cecil C. E. Beddoes. A report of the working of an economical plant. Ills. 1800 w. Eng Rec—June 24, 1905. No. 70382.

Sewerage.

A Failure of the Waring Small-Pipe Sewage System. Full decision of Judge Letton, of the Supreme Court, of Nebraska, in the case of Shannon v. City of Omaha. 1600 w. Eng Rec—June 3, 1905. No. 70057.

Sewer Construction in St. Louis. Curtis Hill. Illustrates and describes interesting features of the sewer construction, the "combined system" being the method used. 3000 w. Trans Assn of Civ Engrs of Cornell Univ—1905. No. 70539 F.

WATER SUPPLY.

Analysis.

The Field Assay of Water. M. O. Leighton. Explanatory remarks with methods for determining the turbidity, color, total hardness, alkali carbonates, normal carbonates, bicarbonates, total sulphates, chlorine, iron, and calcium. 7000 w. Eng News—June 8, 1905. No. 70095.

Artesian Wells.

Deep Wells as a Source of Water Supply for Minneapolis. N. H. Winchell. Shows that there are several water basins below this city which will give an inexhaustible supply at moderate cost. Drawings. 9300 w. Am Geol—May, 1903. No. 70026 D.

Dams.

See Civil Engineering, Construction.

Danville, Ill.

Recent Improvements in the Plant of the Danville Water Company. Daniel W. Meal. Reviews the history of the water-supply of Danville and gives an illustrated description of the plant, the new dam, mechanical filters, etc. Discussion. 7000 w. Jour W Soc of Engrs—June, 1905. No. 70527 D.

Filtration.

Filtration System for Pittsburg. Howard W. Underwood. An illustrated detailed description of the novel features of this system, now under construction. The plant is equal in area to the largest plant in the world. 6500 w. Trans Assn of Civ Engrs of Cornell Univ—1905. No. 70543 F.

We supply copies of these articles. See page 797.

Mechanical Filter at Binghamton, N. Y. George C. Whipple. Illustrated detailed description. 1500 w. Eng Rec—June 17, 1905. No. 70294.

The Management of the Roxborough Water Filters, Philadelphia. Explanation of their management reprinted from a report by John W. Hill. Ills. 2200 w. Eng Rec—June 24, 1905. No. 70379.

Fire Service.

High-Pressure System for Fire Service. Report of Committee of National Fire Protective Assn. Recommends their introduction for certain places, discussing their requirements. 5200 w. Eng Rec—June 3, 1905. No. 70055.

Intakes.

Water Supply Intakes. Herbert E. Bellamy. Discusses particularly those rivers which are liable to large floods and where pumping is necessary. Considers the site of the intake, design, tunnel, etc. Ills. 1000 w. Public Works—April, 1905. No. 69925 F.

Irrigation.

Irrigation Survey of the Upper Snake River Valley, Idaho. E. B. Darlington. Review of the statistics obtained from investigations on a large scale, describing the work done. 1000 w. Eng News—June 1, 1905. No. 70041.

The Irrigation of Egypt. A brief review of the work already accomplished and discussion of proposed work in the valley of the Nile. 3000 w. Engng—June 16, 1905. No. 70510 A.

Pressure Gage.

The Measurement of Low Artesian Heads. Myron L. Fuller. Describes a small, handy gage for taking artesian well pressures, which can be carried in the vest pocket. 700 w. Eng News—June 8, 1905. No. 70097.

Purification.

Water Purification. D. J. Russell Duncan. Read before the Engrs' Club of Toronto. Brief references to various methods, with suggestions for the application of practical processes, economical in operation and maintenance. 4500 w. Can Engr—June, 1905. No. 70127.

Reservoirs.

A Great Indian Reservoir. R. B. Buckley. An illustrated description of the Marikanave reservoir, in Mysore, now approaching completion, which will be the largest in India. 2000 w. Public Works—April, 1905. No. 69929 F.

Ring-Braced Sheet Piling for Reservoir Construction, Kinston, N. C. George A. Rogers. Illustrates and describes the method of using ring-bracing for holding sheet-piling in place while building a circular reservoir. 500 w. Eng News—June 15, 1905. No. 70237.

The Wachusett Reservoir for Boston Water Supply. Illustrated description of this great engineering work, storing 63,000,000,000 gallons. 1300 w. Sci Am—July 1, 1905. No. 70550.

Screens.

Mechanically Operated Screens, Newark Water-Works. Illustrated detailed description of the novel manner of handling these metal framed screens, as given in a paper by J. Ralph Van Duyne. 600 w. Eng Rec—June 3, 1905. No. 70054.

Water-Works.

Ilkeston and Heanor Water-Works. George and F. W. Hodson. Details and illustrations of a very complete waterworks undertaking. 6400 w. Public Works—April, 1905. No. 69933 F.

WATERWAYS AND HARBORS.

Dams.

See Civil Engineering, Construction.

Debris Barrier.

Débris Barrier No. 1, Yuba River, Cal. Illustration, with brief description of structure now being built for holding and storing mine débris in the river. 1000 w. Eng News—June 15, 1905. No. 70232.

Flow.

Flow over a Weir of Curved Profile (Der Abfluss an Einem Grundwehre Kurvenförmigen Profils). Johann Hermanek. A mathematical investigation, discussing the influence of the section of a weir upon the discharge. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—June 2, 1905. No. 70445 D.

Harbor Cableways.

The Provision of Harbor Facilities on Difficult Coasts by Means of Cableways (Die Schaffung von Landungsstellen an sonst Unzüganglichen Küsten mittels Schwebender Transporteinrichtungen). G. Dieterich. Describing the use of a cableway, carried on a cantilever pier for handling cargo, off difficult coasts. Serial. Part I. 2500 w. 1 plate. Glasers Annalen—June 1, 1905. No. 70440 D.

Harbor Works.

Dover Harbor Works. A. T. Walmisley. Reviews what is known of the early history of the harbor, and gives an illustrated description of the recent improvements, the appliances used, the construction work, etc. 10000 w. Public Works—April, 1905. No. 69927 F.

The Bruges Harbor Works. An illustrated description of the works at Zeebrugge, the outer harbor of the maritime canal connecting Bruges with the North Sea. 3300 w. Engng—May 26, 1905. Serial. 1st part. No. 70117 A.

Jetties.

The Southwest Pass Jetties. H. W. Parkhurst. Gives general description and

specifications of work contemplated at New Orleans for the improvement of navigation. Ills. 4000 w. R R Gaz—Vol. XXVIII., No. 24. No. 70266.

Mississippi.

The Mississippi: Controlling Floods, Navigation Improvements. H. Van Meerten. A continuation of the Haupt-Van Meerten discussion. Ills. 5500 w. Jour Fr Inst—June, 1905. No. 70218 D.

Panama Canal.

History and Present Status of the Panama Canal. With illustrations and editorial on the alternative plans for the canal. 3600 w. Sci Am—June 3, 1905. No. 69993.

The Panama Canal (Le Canal de Panama). A. Dumas. An illustrated historical account of the two French companies and of the sale of the concession and works to the United States government. Three articles. 7500 w. Génie Civil—May 6, 13, 20, 1905. No. 70419 each D.

The Panama Canal. Six relief model maps showing the six plans that have been considered for this great undertaking. 1200 w. Marine Engng—June, 1905. No. 70016 C.

The Problem of the Panama Canal. Lindon W. Bates. A brief review of the plans and a discussion of the problems, explaining the terminal lake plan, proposed by the writer. Map. 2500 w. Yale Sci M—June, 1905. No. 70298 C.

Wharf.

A Fireproof Wharf at Tampico, Mexico. E. H. Connor. Illustrated description of a finely equipped, steel concrete, fireproof wharf at which the largest vessels can land. 2500 w. Eng News—June 8, 1905. No. 70102.

The Mexican Central Wharf at Tampico. Illustrated description of a finely equipped, steel-concrete, fireproof wharf which will accommodate the largest vessels. Taken from a pamphlet published by E. H. Connor. 6000 w. R. R. Gaz—Vol. XXXVIII., No. 25. No. 70367.

MISCELLANY.

Explosives.

Stowmarket Explosives' Factories. Outlines the history of this factory and the processes used in the manufacture of gun-cotton, reporting a recent visit. The nitric acid factory, and the manufacture of nitro-glycerine, cordite, etc., are also described. Ills. 5000 w. Engr, Lond—June 9, 1905. No. 70312 A.

Reclamation.

Description of a California Reclamation District. E. D. Van Loben Sels. Describes the lands, crops, methods of reclaiming a swamp land protected from overflow by levees and drained by a system of ditches. Ills. 5800 w. Cal Jour of Tech—May, 1905. No. 70327 C.

The United States Reclamation Service. F. H. Newell. Information concerning this service and the work now under construction. 2500 w. Eng News—June 15, 1905. No. 70233.

ELECTRICAL ENGINEERING

COMMUNICATION.

Exchange.

New Automatic Telephone Exchange at Columbus, Ohio. Illustrated detailed description. 3500 w. Elec Rev, N Y—June 17, 1905. No. 70268.

Printing Telegraph.

Barclay's Printing Telegraph. Illustrated description of the machine, which gives great promise of being practical. 3000 w. R R Gaz—Vol. XXXVIII., No. 23. No. 70164.

Type-Printing Telegraphs. Donald Murray. Reviews the development and outlines the main difficulties that have beset the introduction of the system. Ills. 3200 w. Elec Mag—May 23, 1905. No. 69961 C.

Typo-Telegraph. Frederick J. Swift. Illustrated description of the system originated by Dr. George A. Cardwell. 2200 w. Elec Rev, N. Y—June 24, 1905. No. 70363.

Space Telegraphy.

Absorption of Electromagnetic Waves by Living Vegetable Organisms. George O. Squire. Discusses some of the difficulties met in transmitting electromagnetic waves over land, describing experiments, giving results, and much interesting information. Ills. 9500 w. Jour of Elec—June, 1905. No. 70285 C.

Recent Developments in Wireless Telegraphy. Translated from *Prometheus*. An illustrated review of improvements, showing the present standing of wireless telegraphy. 3500 w. Sci Am Sup—June 17, 1905. No. 70244.

Wireless Telegraphy Measurements. W. Duddell and J. E. Taylor. Read before the Inst. of Elec. Engrs. A report

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of tests made to measure the R. M. S. value of the current in the receiving air wire and to determine how this current depends on the arrangement of the transmitting and receiving apparatus and the distance between them. 3000 w. Elect'n, Lond—June 2, 1905. Serial, 1st part. No. 70188 A

Telegraphy.

The Evolution of the Telegraph in Railroad Work. Charles E. Yetman. Discusses especially the mechanism used in telegraph work and the conditions arising from its use as affecting the telegraph operator. Illustrates and describes the transmitting typewriter. Discussion. 13500 w. Pro N Y R R Club—May 19, 1905. No. 70259.

Telephony.

A Study of Short-Distance Telephony. Valentine Ryan. Considers the installations of short-distance telephones and their working. Elec Engr, Lond—May 26, 1905. Serial. 1st part. No. 70106 A.

Telephone Traffic. Herbert Laws Webb. Describes the improvements that have been made in the conduct of telephone traffic, and discusses the relation between traffic efficiency and engineering economy. 4800 w. Inst of Elec Engrs—May 11, 1905. No. 69936 D.

Time Signals.

The Precise Transmission of Time by Telephone (Transmission Précise de l'Heure par le Téléphone). E. Guyou. The oscillations of a standard pendulum are transmitted by sound, using a special microphone transmitter. 1000 w. Comptes Rendus—May 29, 1905. No. 70433 D.

DISTRIBUTION.

Cables.

Are Lead-Covered Cables Doomed? J. H. C. Brooking. A discussion of the best system of cables to use for the classes of mains now in operation. 3400 w. Elec Mag—May 23, 1905. No. 69964 C.

The Choice of an Insulated Cable. Wallace S. Clark. Read before the Nat. Elec. Lgt. Assn. Gives points to assist in making a wire selection. 4000 w. Elec Rev, N Y—June 10, 1905. No. 70138.

Conductors.

Data Relating to Electric Conductors and Cables. H. W. Fisher. Considers the copper conductor and the insulation, and the pressures that should be applied to different sizes of cables. 2800 w. Am Inst of Elec Engrs—June 19, 1905. No. 70331 D.

Electrical Conductors. A. J. Quigley. Points concerning the manufacture, use, and general characteristics of the various electrical conductors. Ills. 5000 w. Wis Engr—June, 1905. No. 70204 D.

Switches.

High Voltage Oil Switches. Alfred Gradenwitz. Illustrates and describes the design of a German oil switch suggested by Dr. Benischke. 900 w. Engr, U S A —June 15, 1905. No. 70282 C.

ELECTRO-CHEMISTRY.

Concentration.

Electrostatic Concentration. Lucien I. Blake. Discusses the electrostatic separation of ores, describing devices used and their operation. Ills. 2000 w. Eng & Min Jour—June 1, 1905. Serial. 1st part. No. 70028.

Electric Furnaces.

The Borchers Furnace. F. A. J. Fitz Gerald. Describes a furnace used by Despretz in 1849, as the progenitor of the Borchers type, giving data of the latter and the working. Ills. 3500 w. Elec-Chem & Met Ind—June, 1905. No. 70089 C.

Electrometallurgy.

Electrometallurgy of Iron and Steel before the Faraday Society. New information from a paper by F. W. Harbord, read before the Faraday Society. 2500 w. Elec-Chem & Met Ind—June, 1905. No. 70090 C.

Galvanoplasty.

The Electroplating of Leaves and Flowers (Métallisation et Galvanoplastie Artistique des Feuilles et des Fleurs). Francis Marre. Describing an albuminonitrate of silver process for metallising fragile objects, permitting them to be electroplated with various metals. 1500 w. Génie Civil—May 20, 1905. No. 70423 D.

Review.

Electrometallurgy in the year 1904 (Die Elektrometallurgie im Jahre 1904). Dr. Franz Peters. The first instalment discusses the electric smelting of iron and steel. 5000 w. Glückauf—June 10, 1905 No. 70454 D.

Wires.

The Electrolytic Manufacture of Very Fine Wires (Fabrication Electrolytique de Fils Métalliques trés Fins). Henri Abraham. The wire forms a positive electrode and is slowly dissolved in the electrolyte; the increase in its resistance measures its fineness. 1000 w. Comptes Rendus—May 29, 1905. No. 70435 D.

ELECTRO-PHYSICS.

Alternators.

Alternate Current Machinery—Induction Alternators. William Stanley, assisted by G. Faccioli. Discusses some of the elementary phenomena found while studying the performance of alternators excited by alternating currents. 4800 w.

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Am Inst of Elec Engrs—June 22, 1905. No. 70338 D.

The Computation of the Short-Circuit Characteristics of Alternating Generators (Die Vorausberechnung der Kurzschlusscharakteristik von Wechselstrom Generatoren). Dr. Theodor Torda. Deriving formulas and tables for the calculation of the constant from the dimensions and winding. 2500 w. Elektrotech Zeitschr—May 18, 1905. No. 70465 B.

Armatures.

Armature Reaction. Edward Eugene Brown. Read before the Newcastle Soc. of the Inst. of Elec. Engrs. A study, giving report of work of a number of investigators. 3500 w. Elec Engr, Lond—May 26, 1905. No. 70107 A.

Armature Windings of Alternators. F. D. Newbury. A description of armature windings, explaining the characteristics of the unit electromotive forces, and also explaining how the single wires are connected together to form the various types of practical windings and the characteristics of the electromotive forces that result from these various connections. 1500 w. Elec Jour—June, 1905. No. 70221.

Cathode-Ray Tube.

Some Applications of the Braun Cathode-Ray Tube. M. Mansergh Varley and W. H. F. Murdoch. Illustrates and describes a few interesting experiments with the tube. 1300 w. Elect'n, Lond—June 16, 1905. No. 70507 A.

Converters.

External Reactance for Synchronous Converters. Clarence P. Fowler. An explanation of the effect of external reactance on the regulation of rotary converter. 1100 w. Elec Wld & Engr—June 17, 1905. No. 70290.

Dynamotor.

A Diagram of the Circuits of the Dynamotor. A. E. Kennelly and S. E. Whiting. Aims to show that the same principles of graphic representation apply to the circuits of the dynamotor, or direct current transformer, as to the alternating-current transformer. 1000 w. Elec Wld & Engr—June 3, 1905. No. 70070.

Eddy Currents.

Eddy Currents in Large Slot-Wound Conductors. A. B. Field. A discussion of the more important causes of eddy currents in heavy conductors carrying alternating currents and surrounded on their sides by iron. 4500 w. Am Inst of Elec Engrs—June 21, 1905. No. 70333 D.

Electric Waves.

An Experimental Study of Electric Waves and Their Applications. Dr. Edward Branly. An illustrated article studying the production, application, interference, etc. 3000 w. Sci Am Sup—June 24, 1905. No. 70352.

Electromagnets.

The Performance of Different Types of Electromagnets. Charles R. Underhill. Shows the relations between the types in common use. 1000 w. Am Elect'n—June, 1905. No. 70007.

Electrons.

The Dynamics of the Electron (Sur la Dynamique de l'Electron). H. Poincaré. A mathematical examination of the theory of Lorentz, in comparison with the investigations of Laplace upon the action of gravity. 2000 w. Comptes Rendus—June 5, 1905. No. 70437 D.

Hysteresis.

Magnetic Hysteresis Produced by an Oscillating Field Superposed upon a Constant Field (De l'Hysteresis Magnétique Produite par un Champ Oscillant Superposé à un Champ Constant). P. Duhem. Deriving mathematical expressions for the relations of the magnetic effect to the rate of oscillation. 1500 w. Comptes Rendus—May 8, 1905. No. 70429 D.

Power Factor.

Notes on the Power Factor of the Alternating-Current Arc. George D. Shepardson. Presents some results obtained by students at the University of Minnesota, in connection with the graduating thesis work. 1000 w. Am Inst of Elec Engrs—June 22, 1905. No. 70340 D.

Rectifier.

Constant Current Mercury Arc Rectifier. Charles Proteus Steinmetz. An explanation and description of the rectifier system, its operation, characteristics, tests, &c. 4000 w. Am Inst of Elec Engrs—June 19, 1905. No. 70329 D.

Resistance.

The Resistance of Metallic Wires to High-Frequency Currents (Sur la Resistance des Fils Métalliques pour les Courants Electriques de Haute Fréquence). MM. Andre Broca and Turchini. Discussing the application of Kelvin's law to very high frequencies. 1500 w. Comptes Rendus—May 8, 1905. No. 70431 D.

Rheostats.

Water Rheostats. H. M. Phillips. Suggestions for making rheostats, and for increasing or decreasing the resistance, and related matters. 3500 w. Engr, U S A—June 1, 1905. No. 69977 C.

Transformers.

The Design of Transformers. Gives an output formula representing a rule covering various designs from 5 kw. to 1,000 kw. as a basis for calculations. 700 w. Elec Rev, Lond—June 16, 1905. No. 70504 A.

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GENERATING STATIONS.

Berlin.

The Moabit Central Station at Berlin, Germany. Emile Guarini. A brief illustrated description of a very large station. 1800 w. Cent Sta—June, 1905. No. 69972.

Central Stations.

Central Station Protection. A symposium of ideas on the protection of Central Stations from interrupted service. 5000 w. Elec Rev, N. Y.—June 3, 1905. No. 70068.

Combined Plants.

Combined Plants for Small Towns. Oscar Claussen. Shows how water and electric lighting plants can be worked together to advantage in small towns. 1000 w. Munic Jour & Engr—June, 1905. No. 69975 C.

Control.

Booster Field Control. Carl P. Nachod. Describes a convenient method of controlling a separately excited booster field. 700 w. Elec Wld & Engr—June 24, 1905. No. 70387.

Denver.

The Electrical Properties of the Denver Gas and Electric Company. C. W. Humphrey. Illustrated review of the electrical developments, and methods used. 4200 w. Elec Rev, N. Y.—June 3, 1905. No. 70066.

Dynamo.

A Novel Type of Dynamos. Illustrated description of a novel type of direct-current dynamo, which is especially suitable for the lighting of railway trains, designed by Dr. E. Rosenberg. 2000 w. Elec Rev, Lond—June 9, 1905. No. 70306 A.

The Erection of a Direct Current Dynamo. L. H. Pike. Directions for the inexperienced, with illustrations. 3000 w. Power—June, 1905. No. 70063 C.

Generating Sets.

Synchronous Converters and Motor-Generators. W. L. Waters. A discussion of synchronous motor generator sets and synchronous converters. Ills. 5000 w. Am Inst of Elec Engrs—June 22, 1905. No. 70335 D.

Turbo Dynamos and Their Associated Machinery (Turbodynamos und Verwandte Maschinen). F. Niethammer. Illustrating and describing a variety of turbo-dynamo sets, for both steam and hydraulic turbines, with details from German and American practice. Two articles. 7000 w. Zeitschr d Ver Deutscher Ing—May 13, 20, 1905. No. 70400 each D.

Hydro-Electric.

A Brief Account of Two Recent Swiss Water Plants. William E. Mott. Illustrates and describes the plants at Engelberg and at Wangen a Aare. The former is representative of the best Swiss practice in water power plants under high heads; the latter an example of design and construction suitable for installations of this character intended for low heads. 2800 w. Trans Assn of Civ Engrs of Cornell Univ—1905. No. 70541 F.

The Hydro-Electric Installation of Turbigo, Lombardy. Enrico Bignami. Illustrated description of a new plant to operate in parallel with the plant at Vizzola. 1500 w. Elec Rev, Lond—May 19, 1905. No. 69942 A.

The Hydro-Mechanical Arrangement of Recent Electric Stations in Austria (Hydromechanische Einrichtungen von Neueren Oesterreichischen Elektrizitätswerken). Gustav Witz. Describing especially the construction of the hydro-electric plant at Bruck, on the Mur, developing about 4000 horse power. 3000 w. 3 plates. Zeitschr d Oesterr Ing u Arch Ver—June 2, 1905. No. 70444 D.

The Hydro-Electric Power Station at Ladernier. S. Herzog. Illustrated description of a power equipment of interest because of the large extent of the hydraulic distributing system, and the many arrangements for safety in operation. 2200 w. Elec Wld & Engr—June 10, 1905. No. 70154.

The Puyallup River Water Power Development and High Tension Transmission to Seattle and Tacoma, Washington. J. F. Vaughan. An illustrated description of this system recently put in operation. 3500 w. Harvard Engng Jour—June, 1905. No. 70206 D.

Ice Disposal.

The Importance of Ice Disposal on Large Hydraulic Power Developments. Edwin E. Haslam. An illustrated article explaining the difficulties caused by ice, and the methods of protection and disposal. 5000 w. Trans Assn of Civ Engrs of Cornell Univ—1905. No. 70540 F.

Mining Plant.

The Electric Power and Lighting Station of the Dahlbusch Mine (Die Elektrische Kraft und Lichtanlage der Zeche Dahlbusch). Messrs. Le Bell & Bollmann. Fully illustrated description of the plant, including steam engines, steam turbines, pumps, ventilators, buildings, etc. 4000 w. 4 plates. Glückauf—June 3, 1905. No. 70453 D.

New England.

Electric Transmission and Distribution in New England. Illustrates and describes stations of the Connecticut Railway & Lighting Company at Waterbury, Connecticut. 3400 w. Am Elect'n—June, 1905. No. 70004.

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Niagara Falls.

The Development of the Ontario Power Co. P. N. Nunn. A statement of the considerations which led to a departure from the type of construction hitherto installed at Niagara Falls, briefly describing features which may prove to be advances in the art of power-plant design. Ills. 4800 w. Am Inst of Elec Engrs—June, 1905. No. 70252 D.

The Ontario Power Company's Plant at Niagara Falls. E. A. Ekern. Illustrated detailed description. 4800 w. Wis Engr—June, 1905. No. 70203 D.

Power Plant.

Power Plant of the Oliver Plow Co. at South Bend, Ind. Illustrated detailed description of an interesting hydro-electric plant that has been recently improved. 2500 w. Engr, U S A—June 1, 1905. No. 69976 C.

Power Plant Supervision and Accounting. F. W. Ballard. Read before the Ohio Soc. of Mech., Elec., and Steam Engrs. Describes the system of the Sherwin-Williams Co., of Cleveland, O. 2500 w. Engr, U S A—June 1, 1905. No. 69979 C.

The Power Plant of the University of California. A. S. Wheeler. Illustrated description of the new plant, designed for a full load of 200 kilowatts. Oil is used for fuel. 2000 w. Cal Jour of Tech—May, 1905. No. 70324 C.

South America.

Electrical Power Development in South America. Illustrated detailed description of the results accomplished by the Sao Paulo Tramway, Light & Power Co., in Brazil 2500 w. Can Elec News—May, 1905. No. 69954.

Switchboards.

Some European High Tension Switchboards. Prof. Dr. F. Niethammer. Illustrates and describes some of these boards. 900 w. Elec Wld & Engr—June 3, 1905. Serial. 1st part. No. 70071.

Transformers.

Static Disturbances in Transformers. S. M. Kintner. An explanation of the way in which static disturbances are induced. 1000 w. Elec Jour—June, 1905. No. 70223.

Transformer Insulation. O. B. Moore. Discusses the relation of ohmic resistance and dielectric strength. 2000 w. Elec Jour—June, 1905. No. 70220.

Tunnels.

Electric Equipment at the Karawanken Tunnel. Illustrated description of the electric plant for furnishing power for tunnel construction in Austria, with explanation of some of the uses to which the power is applied. 2800 w. Engr, Lond—June 2, 1905. No. 70201 A.

Turbine Station.

The New Turbine Station of the Edison Electric Illuminating Company of Boston. Illustrated detailed description. 3800 w. Power—July, 1905. No. 70391 C.

LIGHTING.

Filament.

A New Carbon Filament. John W. Howell. Gives a report of a carbon filament having characteristics differing from any previously known, due to the proper application of excessively high temperatures to the ordinary carbon filament. 1800 w. Am Inst of Elec Engrs—June 22, 1905. No. 70337 D.

Illuminants.

Notes on the Use of Rare Earths in Electric Illuminants. Murray Charles Beebe. Discusses the work in this field, the difficulties, and experiments. 2700 w. Am Gas Lgt Jour—June 12, 1905. Serial. 1st part. No. 70126.

Illumination.

The Lighting of Residences. E. Leavenworth Elliott. Discusses the lighting of the kitchen, dining-room, library, parlor, bedrooms, etc. 3000 w. Cent Sta—June, 1905. No. 69974.

Lamps.

Comments on Remarks Made by Col. R. E. B. Crompton before the International Electrical Congress at St. Louis. John W. Howell. Remarks made in discussion of papers read by Mr. Torchio and Mr. Dow are given. Reports tests made of English lamps, and also of American lamps, and discusses conditions in England. 1200 w. Am Inst of Elec Engrs—June 19, 1905. No. 70332 D.

Some Recently Improved Forms of the Electric Lamp. F. C. Caldwell. Abstract of a paper before the Ohio Soc. of Mech., Elec., and Steam Engrs. Reviews briefly the essential characteristics necessary for a first-class source of light, and considers recent improvements in efficiency. 2000 w. Engr, U S A—June 1, 1905. No. 69980 C.

Mercury Arc.

The Mercury Arc Lamp and Rectifier. E. Weintraub. Reviews the history of the mercury arc, and gives an outline of work done in the Research Laboratory of the General Electric Company, discussing some of the practical properties, and the mercury arc rectifier. Also editorial. Ills. 5500 w. Elec Wld & Engr—June 3, 1905. No. 70073.

A New Ultra-Violet Mercury Lamp. Dr. O. Schott. Abridged translation of an article in the *Zeitschrift für Angewandte Chemie*. Describes a modification of the Hewitt mercury vapor lamp, and some of

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the uses to which it is applied. 1800 w. Sci Am Sup—June 10, 1905. No. 70173.

Nernst Lamps.

Some Results of Late Mineral Research in Llano County, Texas. William E. Hidden. An illustrated article describing the development of the noted gadolinite locality, known as Barringer-Hill. 2500 w. Am Jour of Sci—June, 1905. No. 69986 D.

Tantalum Lamp.

Tests of the Tantalum Lamp. Dr. Louis Bell and Prof. W. L. Puffer. A preliminary report of tests made of the life of these lamps, and photometric determinations. Illus. 1500 w. Elec Wld & Engr—June 3, 1905. No. 70069.

MEASUREMENT.

Alternating Currents.

A New Instrument for the Measurement of Alternating Currents. E. F. Northrup. Illustrated description of instrument and methods of measuring alternating current instruments, and large alternating currents regardless of their wave form or frequency. 4000 w. Am Inst of Elec Engrs.—June, 1905. No. 70247 D.

The Measurement of Small Alternating Currents. Frederick Bedell. Description of a simple device for measuring small alternating currents. Also editorial. 1200 w. Elec Wld & Engr—June 10, 1905. No. 70156.

Efficiency Tests.

Efficiency Tests of a 400-Kw. Westinghouse-Parsons Turbo-Generator. Gives method of conducting the tests and the details concerning the calibration of instruments, methods of measurement, etc. 1400 w. Eng Rec—June 10, 1905. No. 70184.

High Pressures.

Methods of Measurement of High Electrical Pressures. S. M. Kintner. A summary of the various methods of high-pressure measurement at present employed, pointing out their advantages and faults, and describing a new type of Westinghouse static voltmeter. 5700 w. Am Inst of Elec Engrs—June, 1905. No. 70253 D.

Induction Motors.

Measuring the Slip of Induction Motors. F. Lawton Stone. Describes a mechanical method of measuring the slip which seems well adapted to workshop conditions. Ills. 1200 w. Elec Wld & Engr—June 10, 1905. No. 70155.

Meters.

Magnetic Motor-Meter for Continuous Currents (Magnet-Motorzähler für Gleichstrom). A form of meter for moderate currents using a motor with permanent magnetic field. 1500 w. Elektrotech Zeitschr—May 18, 1905. No. 70464 B.

Rotary Motor-Meter for Continuous Currents (Rotierende Motorzähler für Gleichstrom). Illustrated description of the A. E. G. rotary meter, as approved by the Reichsanstalt. 1500 w. Elektrotech Zeitschr—May 18, 1905. No. 70463 B.

Oscillating Motor-Meter for Continuous Currents (Oscillierende Motorzähler für Gleichstrom). An official report by the Reichsanstalt upon a form of meter for two and three-wire circuits, for pressures of 60 to 600 volts. Full details are illustrated. 2500 w. Elektrotech Zeitschr—May 18, 1905. No. 70462 B.

Photometry.

Note on the Use of White Walls in a Photometric Laboratory. Edward P. Hyde. Aims to show that photometric observations can be made in any room by arrangements described, and corrections measured. Also editorial note. 2500 w. Elec Wld & Engr—June 3, 1905. No. 70074.

Resistance.

Application of the Differential Galvanometer to Exact Measurements of Resistance. W. Jaeger. Translated from *Zeitschrift fuer Instrumentenkunde.* An explanation of the Kohlrausch method. 2500 w. Elec Rev, N Y—June 17, 1905. No. 70269.

Wattmeters.

Determination of Wattmeter Correcting Factors by Means of the Oscillograph. Stanley P. Smith. An account of experiments made with the main object of finding, by the use of the oscillograph, the magnitude of the correcting factor. 1200 w. Elect'n, Lond—June 16, 1905. No. 70508 A.

MOTORS.

Alternating Current.

Alternating-Current Motors in Industrial Service. P. D. Ionides. Abstract of a paper read before the Glasgow Loc. Sec. of the Inst. of Elec. Engrs. Notes on the types used to meet stated requirements. 1500 w. Elect'n, Lond—May 26, 1905. No. 70110 A.

Choice of Motors.

Choice of Motors in Steam and Electric Practice. William McClellan. Discusses this subject, giving a survey of characteristic features of the motive power in the two systems, and calls attention to important points. 4 tables. 2500 w. Am Inst of Elec Engrs—June, 1905. No. 70246 D.

Control.

American Types of Control Apparatus for Direct Current Motors. Laurence B. Mather. Illustrations, with brief descrip-

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tions of the various types and their operation. 8700 w. Am Elect'n—June, 1905. No. 70008.

Motor-Controlling Apparatus. Francis W. Appleton. Brief description of a simple arrangement, which is a condensation of solenoid switches, with suggestions. 800 w. Am Elect'n—June, 1905. No. 70005.

Electric Driving.

Some Problems in Electric Motor Driving. H. S. Knowlton. Suggestions for determining the proper motor outfit for any work, with remarks on the advantages to be gained. 1700 w. Cassier's Mag—June, 1905. No. 69966 B.

Induction Motors.

Note on a Simple Device for Finding the Slip of an Induction Motor. Charles A. Perkins. Describes a simple and inexpensive device used in the laboratory of the University of Tennessee. 600 w. Am Inst of Elec Engrs—June 22, 1905. No. 70339 D.

The Design of Induction Motors. Comfort A. Adams. Gives method of calculating the magnetic leakage, a new method for the calculation of the power factor and other matters of interest. 5400 w. Am Inst of Elec Engrs—June, 1905. No. 70245 D.

Worm Gearing.

Worm Gearing for Railway Motors. Henri Somach. Notes applications made of worm gearing, and gives an illustrated description of a new arrangement for vehicle use, and a statement of the advantages. 900 w. St Ry Jour—June 3, 1905. No. 70049 C.

TRANSMISSION.

High-Power Surges.

High-Power Surges in Electric Distribution Systems of Great Magnitude. Charles Proteus Steinmetz. Review and discussion of a high-power surge, which occurred in the high-potential distribution system of the Manhattan Railway, in New York, during the early days of its electric operation. 5000 w. Am Inst of Elec Engrs—June 19, 1905. No. 70328 D.

High Voltage.

High Voltage Direct Current Transmission. G. W. Worrall. Describes the system developed by M. Thury, which generates continuous current at very high tension and constant current, transmits it to the nearest point of demand, continues it in series through all points supplied and returns it through an insulated line. 2000 w. Power—June, 1905. No. 70062 C.

Insulators.

High-Tension Insulators. Illustrated description of the manufacture and electric testing. 3000 w. Elec Rev, N Y—June 3, 1905. No. 70067.

Lightning Arresters.

The Lightning Arrester. Newton Harrison. Shows that if lightning has a choice of paths it will choose the one having the least impedance, explains the purpose of the arrester, and gives a study of the problem of protection. Ills. 2800 w. Cent Sta—June, 1905. No. 69971.

The Siemens-Schuckert Lightning Arrester Relay (Das Blitzableiter-Relais der Siemens-Schuckertwerke). Alberto Dina. Showing the application of auxiliary discharge points to the horn lightning arrester to enable the gap to be safely increased. 4500 w. Elektrotech Zeitschr—May 25, 1905. No. 70468 B.

Masts.

Earth Connections for Masts and Poles for High-Tension Transmissions (Ueber Erdverbindung für Mastenbeschläge und Holzerne Leitungsmasten bei Elektrischen Hochspannungsleitungen). Norberg Schulz. Data from experience in Norway showing the losses of current through the masts and connections. 1500 w. Elektrotech Zeitschr—May 25, 1905. No. 70469 B.

Potential.

An Experimental Study of the Rise of Potential on Commercial Transmission Lines Due to Static Disturbances Caused by Switching, Grounding, etc. Percy H. Thomas. Describes tests made in an experimental study of "static effects" on full-sized commercial systems. 4000 w. Am Inst of Elec Engrs—June 19, 1905. No. 70330 D.

Regulation.

How to Calculate Regulation. J. S. Peck. Simple methods of calculating the regulation of alternating-current circuits are given. 700 w. Elec Jour—June, 1905. No. 70222.

Voltage.

Selection of Transmission Voltages. Alton D. Adams. Suggestions of value, discussing the factors that determine the voltage. 1200 w. Sci Am—June 17, 1905. No. 70241.

MISCELLANY.

Electrical Energy.

The Supply of Cheap Electrical Energy for Industrial Purposes. J. A. Jeckell. Read before the Birmingham Elec. Club. Considers the supply from central stations, the advantages of a cheap supply, and the possibility of cheap rates. 5500 w. Elec Engr, Lond—May 19, 1905. No. 69941 A.

Fire Hazard.

The Electrical Fire Hazard. William T. Benallack. Briefly reviews the development of artificial lighting, the various

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applications of electricity, etc., and discusses fires caused from an electrical source. Discussion. Ills. 13000 w. Jour W Soc of Engrs—June, 1905. No. 70528 D.

History.

Personal Recollections of the Rise of the Electrical Industry. Prof. Elihu Thomson. An extremely interesting record of the early work in lighting and power, and of the steps by which the present enormous growth was reached. It forms a brief autobiographical account of Professor Thomson's own part in the electrical industry. 4500 w. The Engineering Magazine, July, 1905. No. 70487 B.

Machine Design.

Limitations in Direct-Current Machine Design. Sebastian Senstius. Presents a system of design based directly upon general experimental data and the commercial guarantees of the machine. Deals also with the limitations imposed by the quality of brushes obtainable. 4000 w. Am Inst of Elec Engrs—June, 1905. No. 70249 D.

Pressure.

The Protection of Electrical Installations Against Excess Pressure Rises. Remarks on the disturbing influences and their causes, and the resistances used. 1200 w. Elec Engr, Lond—June 9, 1905. No. 70305 A.

INDUSTRIAL ECONOMY

American Commerce.

The Development of American Commerce (Le Développement du Commerce des Etats-Unis). A. Dumas. A study of the exports, imports and manufactures of the past 30 years and the influence of the Panama Canal and the Pan-American railroad upon American commerce. 2500 w. Génie Civil—May 27, 1905. No. 70425 D.

Arbitration.

Compulsory Arbitration. F. Danvers Power. Discusses the results of the Arbitration Act in Australia, arguing against compulsory arbitration. 2000 w. Eng & Min Jour—June 15, 1905. No. 70274.

Cost-Keeping.

Cost Keeping for the Foundry. R. W. M'Dowell. Read before the Am. Found. Assn. Outlines a system of a general nature, showing the main features of foundry cost accounting. 1700 w. Ir Age—June 8, 1905. No. 70086.

Education.

Some Observations on Mechanical Training. D. Hamilton. Read before the Glasgow Tech. College Sci. Soc. Discusses methods of training, with special reference to Gt. Britain. 5500 w. Prac Engr—June 16, 1905. No. 70500 A.

The New Mechanical Buildings of the Dresden Technical High School (Die Neubauten der Mechanischen Abteilung der Kgl. Sächsischen Technischen Hochschule zu Dresden). A very complete and fully illustrated description of the buildings and equipment. 15000 w. 1 plate. Zeitschr d Ver Deutscher Ing—May 27, 1905. No. 70406 D.

Export Trade.

Engineering Exports of Britain, Germany, and the United States. W. Pollard Digby. Tracing, with the aid of graphic charts, the relative volume of business done by the three great nations in the chief trade zones. Ills. 2500 w. The Engineering Magazine—July, 1905. Serial. 2nd part. No. 70482 B.

Engineering Betterments.

The Engineer as an Economist. C. J. H. Woodbury. From an address at Potsdam, N. Y. Calls attention to inventions whose results have raised mankind and improved the conditions of life; and also the economical results obtained. 4000 w. Ir Trd Rev—June 22, 1905. No. 70356.

Engineering Societies.

The Organization and Administration of National Engineering Societies. John W. Lieb, Jr. Presidential address reviewing the four national engineering societies of America, making reference also to corresponding bodies in Europe. 5000 w. Am Inst of Elec Engrs—June 19, 1905. No. 70334 D.

"Engineer's Fault."

The Engineer's Fault: A Discussion of Specifications, Contracts and Law Suits. John Cassan Wait. Condensed from a paper before the Soc. of Munic. Engrs. of N. Y. City. 6500 w. Eng News—June 8, 1905. No. 70090.

Labor.

Insurance Against Loss of Work (Die Fürsorge für Arbeitslose). Paul Möller. An account of some of the schemes for insuring workmen against hardship from lack of work, as in force in certain establishments in Germany. 3000 w. Zeitschr d Ver Deutscher Ing—June 10, 1905. No. 70415 D.

Organization.

The Organization of Working Forces in

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Large Power-Houses. W. P. Hancock. Read before the Nat. Elec. Lgt. Assn. Describes the organization of the Boston Edison Illuminating Co., at the Third, Fourth and Turbine stations. 6500 w. Eng Rec—June 10, 1905. No. 70183.

Premium System.

The Premium System in Great Britain. J. William Chubb. Explains the attitude of the workmen, methods, results and experiences of various works. 6500 w. Am Mach—Vol. 28, No. 25. No. 70342.

MARINE AND NAVAL ENGINEERING

Battleship.

An Ideal Battleship for the British Fleet. Vittorio Cuniberti. Reprinted from "All the World's Fighting Ships." 2800 w. Marine Rev—June 15, 1905. No. 70258.

Launching of the United States Battleship Nebraska. An illustrated article giving information of the launch and particulars relating to the vessel. 2000 w. Marine Engng—June, 1905. No. 70011 C.

Bending Moments.

Bending Moments of Ships. F. H. Alexander. Read before the Inst. of Naval Archts. A study of the influence of the proportions and form of ships upon their longitudinal bending moments among the waves. Diagrams. 3800 w. Engng—June 9, 1905. No. 70316 A.

Car-Ferry.

Car Ferry Steamer Detroit, Michigan Central Railroad. Illustrated description of a vessel used in the Detroit River service, between Detroit, Mich., and Windsor, Canada. 1100 w. Sci Am Sup—June 3, 1905. No. 69994.

Coaling.

A New Apparatus for Coaling Steamers. An illustrated description of the invention of L. A. de Mayo, and its working. 800 w. Sci Am—June 10, 1905. No. 70169.

Coupling.

The Lovekin Improved Outboard Loose Coupling. Robert S. Riley. Illustrates and describes a type of outboard loose coupling designed with a view to overcoming some of the objections inherent in the sleeve type. 2500 w. Jour Am Soc of Nav Engrs—May, 1905. No. 70521 H.

Cranes.

Shipbuilding Cranes (Hellingkrane). Illustrating electrically driven traveling tower cranes in the Vulcan shipyards at Vegesack, near Bremen. 1000 w. Schiffbau—May 24, 1905. No. 70460 D.

Cruisers.

New Scout Cruisers Chester, Birmingham, and Salem. W. F. Sicard. A detailed description of this class of vessels and the equipment, with comparison with the new British scouts. 4000 w. Jour Am Soc of Nav Engrs—May, 1905. No. 70517 H.

Destroyer.

A Destroyer in Service. Lieut. G. C. Davison. A report of service data for the "Paul Jones." 1800 w. Jour Am Soc of Nav Engrs—May, 1905. No. 70518 H.

The Cavité Floating Dock. Day Allen Willey. Illustrated description of this drydock recently completed for the United States Government in the Philippines. It is entirely of American design and construction, has the greatest lifting capacity of any mechanism ever designed, and many features of interest. 2000 w. Sci Am Sup—July 1, 1905. No. 70551.

Dry Dock.

Cavité Steel Floating Dry Dock. N. A. Berner. Brief illustrated description of a dock costing $1,225,000, for the Philippine waters. 2000 w. R R Gaz—Vol XXXVIII. No. 25. No. 70368.

Floating Dry Docks in Many Navies. Remarks on the value of this type of ship-repairing basin, giving facts in regard to modern dry-docks, and describing the new steel dry-dock for Manila. Ills. 4000 w. Naut Gaz—June 8, 1905. No. 70142.

The Floating Dock of the Aktien Gesellschaft "Neptun," Shipyard and Engine Works, of Rostock, in Mecklenburg. Karl Zublin. Illustrates and describes a dock constructed on the new "Dieckhoff" system. 2700 w. Marine Engng—June, 1905. No. 70013 C.

Fire Boat.

Fire-Extinguishing and Disinfecting Steamer "Clayton." Illustrated description of a steel twin-screw steamer and its equipment. 1000 w. Engng—June 2, 1905. No. 70195 A.

Gas Engines.

The Future of Marine Gas Engines. Peter Eyermann. Reviews the development of the gas engine and producer, and states the advantages. Ills. 4000 w. Jour Am Soc of Nav Engrs—May, 1905. No. 70520 H.

German Navy.

The Development of the German Navy (Die Enwickelung der Deutscher Kriegs-

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marine). H. Haekel. A review of the influence of the development of the German navy upon the progress of German shipbuilding. Serial. Part I. 2000 w. Schiffbau—June 14, 1905. No. 70461 D.

Lifeboat.

The Englehardt Unsinkable Lifeboat. Randolph I. Geare. Brief illustrated description of a boat invented in Copenhagen. 600 w. Sci Am—July 1, 1905. No. 70548.

Marine Shafting.

Recording Angular Velocities of Marine Shafting. John H. Heck. Read before the Inst. of Naval Archts. Notes on the variation of angular velocity in the shafting of marine engines, giving results of many experiments. Ills. 2300 w. Engng—May 26, 1905. No. 70122 A.

Motor Boats.

The Cruise of Napier Major. Extracts from A. F. Evans' report of his recent voyage in this petrol cruising boat. 2000 w. Autocar—May 20, 1905. No. 69934 A.

Oil Engines.

Marine Oil-Engines Consuming Creosote or Other Heavy Oils. Illustrates and describes two medium speed, marine oil-engines recently built by the Griffin Engng. Co., with notes of trials. 2500 w. Engng—May 19, 1905. No. 69946 A.

Reckoner.

Electric Dead Reckoner Used on "Valhalla" in the Ocean Race. Illustrates and describes an automatic dead reckoner and recorder. 1200 w. Sci Am—June 3, 1905. No. 69992.

Scouts.

H. M. Scout "Forward." An illustrated description of this vessel and its equipment, with a report of her most satisfactory performance. 1800 w. Engng—May 19, 1905. No. 69943 A.

Shipping.

The Shipping and Shipbuilding of Puget Sound. Frank W. Hibbs. Read beforce the Soc. of Naval Archts. and Marine Engrs., New York. Information concerning the great number of vessels, their types, the most important items of commerce, etc. Ills. 3000 w. Naut Gaz—June 22, 1905. Serial. 1st part. No. 70373.

Ships.

The Geometry of the Form of Ships (Beitrag zur Geometrie der Schiffsform). O. Richter. A mathematical analysis of the lines of a ship's hull, with numerous tables and diagrams to aid in the practical application of the theory. Four articles. 8000 w. Schiffbau—April 26, May 10, 24, June 14, 1905. No. 70457 each D.

Steamboats.

London County Council Steamboat Service. Brief description of the vessels for the new Thames steamboat service and their engines. 1500 w. Engng—June 16, 1905. No. 70513 A.

Long Island Sound Steamboats. Illustrated detailed description of the recently completed steamboat "Providence," with illustrations of many of the Sound boats, and a tabulated list of these boats. 4000 w. Naut Gaz—June 1, 1905. No. 70043.

The Steamboats of Monmouth County. C. B. Parsons. A review of the history of the Shrewsbury River boats, and others in service from Monmouth County, N. J., to New York. 2500 w. Naut Gaz—June 22, 1905. Serial. 1st part. No. 70374.

Steamships.

Description of Steamship Dakota and Her Official Trial Performance. A. Gundersen. Illustrations, and description of this vessel built for trans-Pacific service. 10500 w. Jour Am Soc of Nav Engrs—May 1, 1905. No. 70522 H.

The Great Northern Steamship Dakota. Illustrated detailed description of this large ship, constructed for the American merchant marine for over-sea trade. 800 w. Marine Engng—June, 1905. No. 70015 C.

The New Steamship Bermudian. Illustrated detailed description of a fine steamship in service between New York and Bermuda. 1000 w. Marine Engng—June, 1905. No. 70010 C.

The Turbine Steamship "Victorian." Report by Com. A. B. Canaga, describing the equipment, and operation. Ills. 5000 w. Jour Am Soc of Nav Engrs—May, 1905. No. 70523 H.

Submarines.

Submarines, "A" and "B" Class. Illustrates British submarines of these two classes, giving brief notes. 350 w. Engr. Lond—June 16, 1905. No. 70515 A.

Submarines. Sir William H. White. From the Engineering supplement of the London *Times*. The present article reviews the history of the construction of these vessels in England and France. 4000 w. Sci Am Sup—June 10, 1905. Serial. 1st part. No. 70172.

Submarine Signalling.

Submarine Signalling by Means of Sound. J. B. Millet. Read before the Inst. of Naval Archts. A review of investigations in this field, and especially recent work and its great value, explaining the system. 4000 w. Engng—May 19, 1905. No. 69948 A.

Torpedoes.

The Protection of Vessels against Torpedoes and Mines (Schutz der Schiffe gegen Torpedos und Minen). Messrs. R. Blochmann and G. Neudeck. A study

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of torpedo warfare, and the improvements in modern warship construction designed to resist their attack. Three articles. 5000 w. Schiffbau—April 12, 26, May 10, 1905. No. 70455 each D.

Transferring Machine.

A Transferring Machine for Ship's Lines, etc. Herman Jonson. Illustrates and describes a machine, designed by the writer, for work in the shipbuilding trade. 1400 w. Am Mach—Vol. 28, No. 23. No. 70132.

Troopship.

The Troopship Dufferin. Illustrated detailed description of the largest and most powerfully armed troopship yet built. 2000 w. Engr, Lond—May 26, 1905. No. 70124 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Clutches.

A Little Talk on Cone Clutches. Rene M. Petard. Discusses this device, and also other types. 1200 w. Automobile—June 1, 1905. No. 69984.

Dust.

Motor Cars and Dust. On the effect of design on the raising of dust, stating the conditions and discussing how far they may be eliminated. 2300 w. Engr, Lond—June 16, 1905. No. 70514 A.

Electric Buckboard.

How to Make an Electric Buckboard. J. C. Brocksmith. An illustrated article, with directions. 1800 w. Am Elect'n—June, 1905. No. 70009.

Eliminating Trials.

The Isle of Man Eliminating Trials. An illustrated report with tabulated results. 4500 w. Auto Jour—June 3, 1905. No. 70185 A.

Fire Engines.

Automobile Fire Engines. George Glendon. An illustrated article presenting the advantages of these machines. 1000 w. Cassier's Mag—June, 1905. No. 69965 B.

Fuel Economy.

Fuel Economy in Car Driving. E. W. Walford. Suggestions showing the good and bad methods. 2800 w. Autocar—May 27, 1905. No. 70104 A.

Gearing.

Transmission Gearing Efficiency Test Rene M. Petard. An illustrated report of experiments recently carried out in France to determine the efficiency of the transmission gearing of the modern automobile. 1200 w. Automobile—June 22, 1905. No. 70357.

The Hitchon Change Speed Gears. Illustrated description of this gear which at the instant of changing is so arranged that the next higher or lower speed gear wheels must be in mesh before the other transmission gearing of the modern autocar—June 10, 1905. No. 70300 A.

Hill Climbing.

Climbing Dead Horn Hill in Worcester. An illustrated account. 2200 w. Automobile—June 1, 1905. No. 69983.

Mail Wagons.

Electric Mail Automobiles. Illustrated description of vehicles in use in Paris, and in the United States. 1200 w. Sci Am—June 3, 1905. No. 69991.

Military.

Automobiles for Military Transport (Transports Automobiles Militaires). Lt. Col. G. Espitallier. Describing the successful use of a Brillié petrol truck in hauling a train of artillery in the Portuguese army. 3000 w. 1 plate. Génie Civil—June 10, 1905. No. 70428 D.

Municipal Vehicles.

Municipal Vehicles in the City of Paris. Illustrated descriptions of various types used, with report of their success. 1600 w. Automobile—June 8, 1905. Serial. 1st part. No. 70143.

Omnibus.

Automobile Omnibus in Paris (Les Omnibus Automobile à Paris). Lt. Col. G. Espitallier. A detailed description of the Gardner-Serpollet steam omnibus now in successful operation in Paris. 2000 w. 1 plate. Génie Civil—May 20, 1905. No. 70421 D.

Racing Car.

The 1905 Renault Racing Car. An illustrated article giving particulars of these cars. 1500 w. Autocar—June 10, 1905. No. 70301 A.

Simms-Welbeck.

The 1905 Simms-Welbeck Cars. Begins an illustrated description of these British built cars. 500 w. Auto Jour—June 10, 1905. Serial. 1st part. No. 70302 A.

Steering.

Analysis of Steering-Knuckle Angles of Automobiles. Herbert L. Towle. Discusses the most suitable angles of inclination of the arms of the steering

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knuckles with respect to the wheel base and other conditions involved. 1300 w. Am Mach—Vol. 28, No. 23. No. 70136.

Touring Cars.

St. Louis Four-Cylinder Touring Car. Illustrates and describes a car built with a view to obtaining great motor flexibility. 1800 w. Automobile—June 8, 1905. No. 70144.

Truck.

Mitchell 1,500-Pound Gasoline Truck. Illustration, with description, and remarks on novel features. 1300 w. Automobile—June 15, 1905. No. 70256.

New Type of Electric Truck. Illustrated description of a truck fitted with a single electric motor within each wheel. 1000 w. Sci Am—June 24, 1905. No. 70350.

COMBUSTION MOTORS.

Alcohol.

Alcohol as a Fuel for Motors. From a paper by Dr. Ormandy before the Western Sec. of the Scottish Auto. Club. The present article discusses the heat required to vaporize, the range of explosibility, and the boiling points. 1200 w. Automobile—June 15, 1905. Serial. 1st part. No. 70255.

Carburetter.

The Napier Carburetter. Illustrates and describes the present type of Napier carburetter. 1000 w. Autocar—June 17, 1905. No. 70398 A.

Diesel.

500-Horse-Power Diesel Engine at the Liege Exhibition. Illustrations, principal dimensions and description. 1100 w. Engng—June 9, 1905. No. 70314 A.

The American Diesel Engine. E. D. Meier. An explanation of the working of this engine, with illustrations, and a comparison with the thermal efficiencies of a steam engine. 3000 w. Harvard Engng Jour—June, 1905. No. 70207 D.

Gas Engines.

Gas Engines and Their Breakdowns. Extract from an article in the *Vulcan*, giving details of gas-engine crank shaft failures, with comments. 1500 w. Mech Engr—June 3, 1905. No. 70186 A.

Large German Gas Engines. Abstract of an address delivered before the Soc. of German Engrs. by Prof. Riedler, who describes and criticises the principal makes of large gas engines built in Germany, and gives a short history of internal combustion engines in general. Ills. 3500 w. Ir Age—June 22, 1905: Serial. 1st part. No. 70345.

The Cockerill Gas-Engines at the Liége Exhibition. Two illustrations and brief descriptions of the three engines exhibited. 600 w. Engng—June 2, 1905. No. 70194 A.

The Mechanical Efficiency and Indicated Capacity of the Gas Engine. (Der Mechanische Wirkungsgrad und die Indizierte Leistung der Gasmachine.) Rudolf Diesel. An exmination of the various conditions under which the efficiency of an internal-combustion motor may be stated, with especial reference to the tests of the Diesel motor. 3000 w. Zeitschr d Ver Deutscher Ing—May 20, 1905. No. 70405 D.

The Present Position of the Gas Engine. Horace Allen. Outlines the combination, fully proved to be satisfactory, which, in the writer's opinion, explains the present position. Also considers points bearing on this subject. 1200 w. Elec Rev, Lond—May 26, 1905. No. 70109 A.

See also Marine Engineering.

Gasoline Motor.

The Lister Two-Cycle Twin-Piston Engine. Illustrations, sectional views, and description of the working. 700 w. Sci Am Sup—June 17, 1905. No. 70243.

Petrol Engine.

The Pollard Compound Petrol Engine. An illustrated article explaining the principle and construction of this engine. 2000 w. Auto Jour—May 20, 1905. No. 69935 A.

See also Marine Engineering, Oil Engine.

Producer-Gas.

Producer-Gas Power Plants. A. Frederick Collins. Illustrates and describes two forms of the suction type of apparatus, the Loomis-Pettibone system, and the Crossley system. 2000 w. Sci Am Sup—June 3, 1905. No. 69997.

Starting.

Methods and Suggestions for the Starting of Gas Engines. R. Mathot. Describes the various systems adopted—mechanical, explosion, etc., and advocates particularly the use of compressed air according to a plan described in detail. 1800 w. The Engineering Magazine—July, 1905. No. 70486 B.

Waste Gases.

Power From Waste Furnace Gases. Brief illustrated descriptions of some of the largest installations of gas engines for utilizing the waste gases from blast furnaces. 1400 w. Power—June, 1905. No. 70064 C.

Wood Gas.

Wood Gas for Power Purposes and Gas Generators. George M. Douglas. Read before the Inst. of Min. and Met. Describes the plant of the Montezuma Cop-

per Co., at Nacozari, Mexico, and its operation. Ills. 3500 w. Inst of Min and Met—April 13, 1905. No. 70114 D.

HEATING AND COOLING.

Heating Plant.

Heating and Ventilating System of the Majestic Theatre, Boston, Mass. Plans and description of the interesting features of this plant. 1300 w. Eng Rec—June 17, 1905. No. 70297.

Low Temperatures.

The Production of Very Low Temperatures. Begins a review of work in this field referring to the British exhibit at the St. Louis Exhibition and the lectures given there. Ills. 2500 w. Engr, Lond—June 2, 1905. Serial. 1st part. No. 70197 A.

HYDRAULICS.

Centrifugal Pumps.

The Efficiency of Centrifugal Pumps (Die Kreisel und Ihre Leistungen). H. Hagens. Giving details of construction of several centrifugal and turbine pumps, with tabulated tests of their performance. 4000 w. Zeitschr d Ver Deutscher Ing—May 20, 1905. No. 70404 D.

Governor.

The Bouvier Governor for Water Turbines. Dr. Alfred Gradenwitz. Illustrated description of an apparatus in which any disturbance occurring in the resisting work is corrected by a corresponding displacement of the gate mechanism. 1400 w. Mach, N Y—June, 1905. No. 70001 C.

Pumps.

Types of Centrifugal Pumps. William O. Webber. Considers recent improvements in these pumps, methods of balancing compound pumps, etc. Illustrates types. 1500 w. Cassier's Mag—June, 1905. No. 69970 B.

Water Power.

Water Power Development at Little Falls, Minn., and Its Industrial Results. Arthur Warren. Describes the conditions at this city on the upper Mississippi River, the water storage system, natural power advantages, dam, power station, industries, etc. Ills. 3500 w. Eng Rec—June 3, 1905. No. 70052.

Water-Powers.

Water-Powers of the Southeastern Appalachian Region. Frederick A. C. Perrine. Considers the powers in the states of Virginia, North Carolina, South Carolina, Georgia, and Alabama. 4500 w. Am Inst of Elec Engrs—June 22, 1905. No. 70336 D.

See also Electrical Engineering, Generating Stations, Hydro-Electric.

MACHINE WORKS AND FOUNDRIES.

Armor Plate Machinery.

Armor Plate Nut-Facing and Chamfering Machine. Illustrates and describes two machines, made in England, for facing, chamfering and turning cylindrical parts of armor plate nuts. 600 w. Am Mach—Vol. 28. No. 26. No. 70535.

Castings.

Casting a Slide-Valve Cylinder. R. H. Palmer. Illustrated description of method used. 1200 w. Am Mach—Vol. 28, No. 25. No. 70343.

Corners on Castings. Walter J. May. An illustrated article showing that rounded edges are stronger than angles, and discussing points bearing on the strength of castings. 1200 w. Prac Engr—June 9, 1905. No. 70304 A.

Melting Steel with Cast Iron. R. P. Cunningham. Read before the Am. Found. Assn. Points on the selection of pig iron and scrap, and the care in charging the cupola to secure strong castings that will machine easily. 1800 w. Ir Age—June 8, 1905. No. 70084.

Copper Plating.

Notes on Copper Plating of Steel Parts of Sights at the Naval Gun Factory. Titus Ulke. Gives briefly the data on which good practice in copper plating is based. 600 w. Am Mach—Vol. 28. No. 23. No. 70135.

Cores.

Venting of Cores. Jas. A. Murphy. Read before the Am. Found. Assn. Describes a machine for making the wax wire used for venting, with speed and economy. Ills. 900 w. Ir Trd Rev—June 8, 1905. No. 70140.

Cupolas.

The Cupola System of the Michigan Store Company. W. J. Keep. Read before the Am. Found. Assn. Describes this plant and the performance of the cupolas and blower. 1400 w. Ir Age—June 8, 1905. No. 70085.

Dies.

A Novel Blanking and Piercing Die. C. F. Emerson. Illustrated explanation of a useful die. 900 w. Am Mach—Vol. 28. No. 24. No. 70229.

Drill.

An English Two-Spindle Radial Drill and Some Workshop Gages. I. William Chubb. Illustrated descriptions. 600 w. Am Mach—Vol. 28. No. 26. No. 70533.

Electric Driving.

Installing Electric Machinery. Norman G. Meade. Suggestions for light and power wiring in shops and foundries. Ills. 500 w. Power—July, 1905. No. 70393 C.

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Flasks.

Flasks for Brass Foundries. C. Vickers. Read before the Am. Found. Assn. Gives an excellent shape for a flask for all kinds of brass work, discussing also the advantages of an overhead track in the foundry. 900 w. Ir Age—June 8, 1905. No. 70087.

Foundry.

Foundry Department of the Imperial Works of the Oil Well Supply Company, Oil City, Pa. Illustrated description of the gray iron and malleable foundries. 1800 w. Foundry—June, 1905. No. 70226.

Foundries of the Pennsylvania R. R. at Altoona. Illustrated detailed description of one of the largest and best equipped foundry plants in the United States. 4000 w. Ry & Engng Rev—June 10, 1905. No. 70177.

Iron and Steel in the Foundry. E. L. Rhead. Discusses the suitability of a metal for making castings, the extrusion of impurities during solidification, influence of specific and latent heat, etc. Ills. 2400 w. Mech Engr—May 27, 1905. Serial. 1st part. No. 70112 A.

Some Difficulties Met With in Small Jobbing Foundries. Walter J. May. Suggestions for overcoming such difficulties. 1700 w. Prac Engr—June 16, 1905. No. 70399 A.

Some Mechanical Relics of the Civil War. Illustrated description of a confederate gun factory and its equipment, in Virginia. 2000 w. Am Mach—Vol. 28, No. 23. No. 70130.

Gear Cutting.

New Brown & Sharpe Automatic Gear Cutting Machine. Illustrated detailed description. 1500 w. Ir Age—June 29, 1905. No. 70524.

Practical Hints on Gear Cutters. T. S. Bentley. Discusses points in the replacing of broken or worn gears from the standpoint of practice. Gives table for the selection of cutters for bevel gears. 1200 w. Am Mach—Vol. 28. No. 25. No. 70341.

The Nardin Bevel Gear Cutter. Georges Levy, in the *Revue Industrielle*. Illustrated description of a bevel gear generating machine and its operation. 1700 w. Am Mach—Vol. 28. No. 23. No. 70131.

Grinder.

A New Electrically-Driven Toolroom Grinder. Illustrated description of a machine arranged for direct connected motor driving. 1100 w. Am Mach—Vol. 28. No. 22. No. 70018.

Index Plate.

Making an Accurate Index Plate. Otto Eckelt. An illustrated description of method. 500 w. Am Mach—Vol. 28. No. 24. No. 70230.

Lathes.

Analysis of Some Engine-Lathe Drives. Sketches and table giving results of work undertaken to determine which of nine lathes of various sizes and makes were best suited to certain diameters of work; also which were most suitable for the heaviest work. 2000 w. Am Mach—Vol. 28. No. 23. No. 70134.

3x36 Turret Lathe. Illustrated description of a tool exhibited at the St. Louis Exposition. 1300 w. Am Mach—Vol. 28. No. 24. No. 70231.

Melting Ratios.

Some Retort Coke Melting Ratios. C. M. Schwerin. A report of some tests made by the writer. 2200 w. Ir Age—June 15, 1905. No. 70210.

Metal Mixers.

Metal Mixers for Pipe Foundries. J. B. Nau. Read before the Am. Found. Assn. Remarks on European practice in pipe foundries, and the advantages of the heated mixer. 1700 w. Ir Age—June 8, 1905. No. 70088.

Milling Machine.

Vertical Milling Machine. Illustrated description of a machine made in Birmingham, England. 1200 w. Engr, Lond—June 2, 1905. No. 70200 A.

New Works.

The Close Works, Gateshead. Illustrated description. 2700 w. Engr, Lond—May 19, 1905. No. 69950 A.

The Brighton Works of the Reason Manufacturing Co., Ltd. Illustrated description of the works and some of the meters, fans, arc lamps, and other accessories manufactured. 3300 w. Elec Mag—May 23, 1905. No. 69963 C.

The New Pawling and Harnischfeger Plant. Illustrated description of a Milwaukee plant for the manufacture of cranes, hoists, boring mills, steam sawmill feeding engines and electrical machinery. 3000 w. Ir Age—June 15, 1905. No. 70209.

The New Works of the Ingersoll-Sergeant Drill Company at Phillipsburg, New Jersey. Full illustrated detailed description of these fine works and their equipment. 3500 w. Am Mach—Vol. 28. No. 22. Serial. 1st part. No. 70017.

Patterns.

Aluminum as a Pattern Metal. H. N. Tuttle. Discusses the advantages of this metal and also the objections. 3500 w. Foundry—June, 1905. No. 70228.

Care and Storage of Patterns. H. M. Lane. Read before the Am. Found. Assn. Considers methods of storing metal and wood patterns, the protection against fire,

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etc. 1500 w. Ir Age—June 22, 1905. No. 70344.

Skeleton Patterns. H. J. M'Caslin. Illustrated description of the construction of the skeleton and method of making the mold. 1600 w. Foundry—June, 1905. No. 70227.

Pipe Joints.

Some New Forms of Flanged Pipe Connections for High-Pressure Superheated Steam and Hydraulic Work. Luther D. Lovekin. Gives illustrations, with brief descriptions, of joints which the writer considers most suitable for the uses named. 1300 w. Am Mach—Vol. 28. No. 23. No. 70133.

Test of Pipe Joints. From a report by Com. T. F. Burgdorff. Describes tests in expanding, flaring and facing a 20-in. lap-welded steel pipe, 3/8-in. thick, into a grooved steel flange by a Lovekin pipe-flanging machine, and the testing of various forms of flanges by hydraulic pressure. Ills. 5500 w. Jour Am Soc of Nav Engrs—May, 1905. No. 70519 H.

Planing Machine.

Heavy Vertical and Horizontal Planing Machine. Illustration and brief description of a machine made in Scotland. 600 w. Engng—June 2, 1905. No. 70196 A.

High-Speed Planers. A. L. De Leeuw. Discusses planing machine driving and the adapting of planers to the use of high-speed steel. 10000 w. Mach, N Y—June, 1905. 70000 C.

Planing Machine Drives. C. H. Benjamin. Discusses this subject with special reference to American practice in motor connection, and gives an illustrated description of a method exhibited at the St. Louis Exposition. 2200 w. Cassier's Mag—June, 1905. No. 69969 B.

Plaster of Paris.

Plaster of Paris in the Foundry. Edward B. Gilmour. Read before the Am. Found. Assn. Describes the method of using this material with success. Ills. 700 w. Ir Trd Rev—June 8, 1905. No. 70141.

Power Plant.

The Power Plant of the Ingersoll-Sergeant Drill Company's Works at Phillipsburg, N. J. Illustrated detailed description of a plant where the power is generated in a central power station and distributed by electricity and compressed air to the various points at which it is required. 2200 w. Power—June, 1905. No. 70060 C.

Purchase Department.

The Relation of Purchasing to Economical Production. Wm. D. Ennis. Detailing a plan for organizing the duties and systematizing the work and records of the purchasing agent to the highest advantage of the efficiency of the factory. Ills. 4000 w. The Engineering Magazine—July, 1905. No. 70483 B.

Rivets.

Hydraulic-Driven Rivets. Frank B. Kleinhans. Directions for good work in rivet driving. Ills. 900 w. Boiler Maker—June, 1905. No. 70153.

Stacks.

Development of Bottom Cone for Stack. T. J. M'Dermott. Drawings and description of a successful scheme. 250 w. Boiler Maker—June, 1905. No. 70152.

Turning Mill.

Mill for Turning and Finishing Boiler Heads (Drehwerk zum Abdrehen und Ausschneiden von Kesselboden). With photograph and details of a vertical turning lathe, especially adapted for finishing pressed-steel boiler heads. 1000 w. Zeitschr d Ver Deutscher Ing—June 10, 1905. No. 70417 D.

Type-Casting.

The Stringer Type Composing and Casting Machine. Illustrated description of an ingenious machine for composing and casting type. 2500 w. Engr, Lond—June 16, 1905. No. 70516 A.

Welding.

A New System of Welding. Prof. A. H. Sexton. Describes a system of welding by means of the oxy-hydrogen flame. 1600 w. Mech Engr—June 17, 1905. No. 70501 A.

MATERIALS OF CONSTRUCTION.

Alloys.

Copper Alloys. L. Guillet, in *Revue de Métallurgie*. A report of researches in special brasses and quenching of bronze. Ills. 1100 w. Ir and Steel Mag—June, 1905. Serial. 1st part. No. 70224 D.

On the Magnetic Qualities of Some Alloys Not Containing Iron. J. A. Fleming, and R. A. Hadfield. An account of preliminary results obtained in experimental investigations of magnetic alloys. 3000 w. Elect'n Lond—June 16, 1905. No. 70505 A.

On the Natural Iron-Nickel Alloy, Awaruite. George S. Jamieson. Describes two iron-nickel alloys from adjoining locations. 1000 w. Am Jour of Sci—June, 1905. No. 69985 D.

Cast Iron.

The Effect of Manganese in Low Silicon Cast Iron. H. C. Loudenbeck. Read before the Am. Found. Assn. A report of tests made to show the effect of manganese on the chill and fracture of cast iron having a low percentage of silicon. 1000 w. Am Mfr & Ir Wld—June 15, 1905. No. 70257.

The Testing of Cast Iron. Dr. Richard

Moldenke. A summary of modern practice. Also discussion. 6200 w. Jour Fr Inst—June, 1905. No. 70217 D.

Chilled Wheels.

The Manufacture of Chilled Wheels. P. H. Griffin. Presents the wheel maker's position in the controversy over the failure of such wheels under high capacity cars. 3500 w. R R Gaz—Vol. XXXVIII. No. 24. No. 70264.

Rivets.

The Shearing Strength of Rivets. Report read at the Chicago convention of the Master Steam-Boiler Makers. 1200 w. Ir Age—June 29, 1905. No. 70525.

Toughness.

The Modifications in the Toughness of Boiler Plate with Increase in Resistance (Die Aenderung der Zähigkeit von Kesselblechen mit Zunahme der Festigkeit). C. Bach. With tables and diagrams giving the results of numerous tests showing the reduction in elongation with increase in breaking resistance. 2000 w. Zeitschr d ver Deutscher Ing—May 13, 1905. No. 70401 D.

MEASUREMENT.

Calorimetry.

Observations upon Calorimetric Methods (Observations sur les Méthodes Employés en Calorimétry). M. Berthelot. A study of the determination of the heat of combustion of organic substances by means of the calorimeter. 2500 w. Comptes Rendus—June 5, 1905. No. 70436 D.

The Commercial Value of the Lewis Thompson Calorimeter. J. S. S. Brame. Summarizes results given in two recent papers, and gives further information showing that only approximate results can be obtained with bituminous coals, while with other coals the figures have no value. 1800 w. Engr, Lond—May 19, 1905. No. 69949 A.

The Junker Calorimeter for the Determination of Heating Values (Das Junkers-Kalorimeter als Heizwertanzeiger). P. Meyer. A brief discussion of the method of using the Junker calorimeter in such manner as to obtain the thermal values of gaseous fuels with a high degree of precision. 1200 w. Zeitschr d ver Deutcher Ing—June 3, 1905. No. 70411 D.

Flow.

A New Method of Using the Pitot-Darcy Tube to the Measurement of the Velocity of Water in Pipes (Nouveau Mode d'Application du Tube de Pitot-Darcy à la Mesure de la Vitesse des Conduites d'Eau Sous Pression). H. Bellet. By using a liquid of different density than water in one leg of a U-tube, very precise readings may be made. 800 w. Comptes Rendus—June 5, 1905. No. 70439 D.

Fourier's Analysis.

Fourier's Analysis Applied to the Plain Slide Valve Gear. W. F. Durand. A discussion of the application of this method to the motion of the plain slide valve gear, with special reference to its comparison with the motion of the piston expressed by the same form of expansion. 1800 w. Sib Jour of Engng—June, 1905. No. 70205 C.

Integrator.

Amsler's Mechanical Integrators. Cecil H. Peabody. An illustrated explanation of this instrument for determining moments and moments of inertia of plane figures. 4000 w. Marine Engng—June, 1905. No. 70012 C.

Pitot Tube.

The Pitot Tube as an Instrument for Measuring the Velocity of Water Flowing in Closed Tubes. Raymond S. Daniels. Describes investigations performed in the hydraulic laboratory of the University of California, their objects, and the results. Ills. 3000 w. Cal Jour of Tech—May, 1905. No. 70326 C.

Speeds.

Method of Calculating Cone-Pulley and Back-Gear Speeds. E. J. Lees. Gives table, with explanation of method. 900 w. Am Mach—Vol. 28. No. 23. No. 70137.

Testing Instruments.

Types of German Testing Instruments. Dr. Alfred Gradenwitz. A brief illustrated review of types exhibited at the recent Jubilee of the German Electrical Society. 2000 w. Elec Mag—May 23, 1905. No. 69962 C.

Testing Station.

The Materialprüfungsamt Near Berlin. A description of the new testing station in one of the suburbs of Berlin, which was recently completed, and of the equipment for testing various materials. 2500 w. Engng—June 16, 1905. No. 70511 A.

Torsion.

The General Applicability of the Torsion Formula of Saint Venant (Mitteilung zur Gültigkeit der Saint-Venantschen Formal für den Verdrehungswinkel). C. Bach. A brief note, showing the inapplicability of the formula to prisms of all sections. 600 w. Zeitschr d Ver Deutscher Ing—June 10, 1905. No. 70416 D.

POWER AND TRANSMISSION.

Ball Bearings.

Experiments upon the Efficiency of Ball Bearings. (Expériences sur le Rendement des Roulements à Billes). Describing the experiments of M. Gé-

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gauff at Mulhouse, Alsace, with a special form of dynamometer, upon the resistance of various designs of ball bearings. 1500 w. Génie Civil—May 20, 1905. No. 70422 D.

Belts.

Horse-Power of Belting. N. A. Carle. Diagram for computing the horse-power, with explanation of its use. 700 w. Power—June, 1905. No. 70061 C.

Compressed Air.

Air Compression in Great Britain. James Tonge. Illustrated description of a number of the leading compressor plants at mines. 4000 w. Mines & Min—June, 1905. No. 70083 C.

Tests of a "Reidler" Two-Stage Air Compressor. William D. Hamilton. A report of trials made to demonstrate the capacity and efficiency of a "Reidler" compressor. Ills. 1000 w. Prac Engr—May 26, 1905. Serial. 1st part. No. 70111 A.

Clutch.

The Friction Clutch. John Edgar. Considers only the expansion-ring frictions, explaining the theory of its action, and the design. 900 w. Am Mach—Vol. 28. No. 26. No. 70534.

Flywheels.

Fly Wheel Explosions. William H. Boehm. Remarks on the frequency of these disasters, their causes, the safe speeds for various types of wheels, etc. Ills. 4000 w. Ins Engng—June, 1905. No. 70319 C.

Gas Power.

A Commercial Comparison between Blast Furnace Gas Engines and Steam Engines in the Minette District (Des Wirtschaftliche Verhältnis zwischen Gichtgasmotoren und Dampfmaschinen im Verhüttungsgebiet der Minette). L. Ehrhardt. A detailed examination of the cost of power from gas and steam in iron works in Germany. 4000 w. Zeitschr d Ver Deutscher Ing—June 3, 1905. No. 70410 D.

Gearing.

See Mechanical Engineering, Automobiles.

Gears.

An Example of Worm Gearing. Oscar E. Perrigo. Illustrated description of a mechanism that has met successfully very rigid requirements. 1400 w. Mach, N Y —June, 1905. No. 70002 C.

New Devices.

Two New Power Transmission Devices. Brief illustrated descriptions of Pope's spring sprocket, and the Newman variable-speed gear. 1500 w. Eng News —June 8, 1905. No. 70096.

Valves.

Progress in Valves for Air and Gas Compressors. Leicester Allen. Discussing the problems presented to the designer, the difficulties characteristic of various types of compressors, and the improbability of finding any completely satisfactory solution. 2600 w. The Engineering Magazine, July, 1905. No. 70484 B.

Wire Rope.

Wire Rope Transmission. C. Boysen. States their advantages over hemp rope, and gives information of value relating to their use. Ills. 900 w. Power—June, 1905. No. 70065 C.

STEAM ENGINEERING.

Belleville.

The Belleville Exhibit at the St. Louis Exposition. (Die Ausstellung der Société Anonyme des Etablissements Delaunay-Belleville). Fr. Frolich. An illustrated review of the latest types of Belleville engines and boilers as shown at the St. Louis exposition. 1800 w. 1 plate. Zeitschr d Ver Deutscher Ing—June 10, 1905. No. 70414 D.

Boiler Efficiency.

The Real Efficiency of Steam Boilers. W. H. Booth, Calls attention to errors in the customary method of calculating the efficiency. 1000 w. Elec Rev, Lond —May 26, 1905. No. 70108 A.

Test of Parker Water-Tube Boilers. Describes the installation in a power station of the Philadelphia Rapid Transit Co., reporting test. Ills. 1200 w. Eng Rec—June 24, 1905. No. 70384.

Boiler Plants.

Boiler Plants in Bleaching and Dying Mills. George I. Rockwood. Abstract of a paper read before the N. E. Cotton Mfrs. Assn. Suggestions for the arrangement and the economical working. 2500 w. Engr, U S A—June 1, 1905. No. 69978 C.

Boilers.

Boilers at the Liége Exhibition. Illustrations, with brief descriptions of the Solignac-Grille, the Jacques-Piedboeuf, and the Bailly-Mathot boilers. 1800 w. Engng—June 9, 1905. No. 70315 A.

Steam Boilers at the Liége Exhibition. Describes the boilers exhibited by Messrs. Vve. L. de Naeyer & Co., illustrating one of the water-tube boilers. 500 w. Engng —May 26, 1905. No. 70119 A.

The Computation of the Strength of a Water-Tube Boiler (Festigkeits Berechnung eines Wasserrohrkessels). Detailed calculations for a water-tube boiler of the Thornycroft-Schulz type. 1500 w. Schiffbau—April 12, 1905. No. 70456 D.

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Compounding.

Compound Reversing Engines. Willibald Trinks. Presents the advantages of compound condensing reversing engines, discussing the cross compound and twin tandem compound, etc. Also discussion. Ills. 4200 w. Pro Engrs Soc of W Penn—June, 1905. No. 70321 D.

Test of a Compound Engine. Report by Michael Longridge of a test made on a vertical two-crank engine, with general description of the engine, boiler and superheater, in which all previous records were beaten. Ills. 3500 w. Engr, Lond —June 2, 1905. No. 70199 A.

Compression.

Tests upon the Influence of Compression upon Steam Engine Economy (Versuche über den Oekonomischen Einfluss der Kompression bei Dampfmaschinen). Dr. Herbert Klemperer. Discussing experiments made at the laboratory of the Dresden Polytechnic, showing the conditions under which compression may partially overcome the evils of clearance. 5000 w. Zeitschr d Ver Deutscher Ing—May 20, 1905. No. 70403 D.

Condensation.

Condensation Losses in Engine Cylinders. George T. Hanchett. Explains what is known as Hirn losses, gives the method of determining the economy of an engine by the use of the formula of Robert C. Heck, which gives satisfactory results. 1600 w. Cent Sta—June, 1905. No. 69973.

Corliss Engine.

1500-I.-H.-P. Corliss Engine for the Transvaal. Illustrated description of an engine recently built for the Premier Diamond Mining Co., Ltd., of the Transvaal. 700 w. Engng—May 19, 1905. No. 69944 A.

Exhaust Steam.

Utilization of the Exhaust Steam From Turbines. Franz Koester. A short illustrated description of the installation and operation of a steam turbine plant in a brewery at Rotterdam. 2000 w. Elec Wld & Engr—June 3, 1905. No. 70072.

Explosion.

The Brockton Boiler Explosion. A full illustrated account of the explosion in the factory of R. B. Grover & Co., manufacturers of the Emerson shoe. Also an explanation of the cause. 8000 w. Locomotive—April, 1905. No. 69937.

Feed Water.

System of Hot Feed Water for Stationary Boilers and Shop Heating. A. A. Maver. Read before the Canadian Ry. Club. Illustrates and describes a system in use at the locomotive works of the Grand Trunk Ry., at Montreal. 1400 w. Dom Engng—June 3, 1905. No. 70033.

Firing.

The Firing of Babcock and Other Boilers by Waste-Heat from Coke-Ovens. T. Y. Greener. Gives details of evaporation tests of boilers attached to coke-ovens at various collieries, with descriptions of boilers, ovens, chimneys, etc. Discussion at London meeting of the Inst of Min. Engrs. 3500 w. Ir & Coal Trds Rev—June 2, 1905. No. 70202 A.

Indicating.

How to Indicate the Engine. George P. Pearce. Directions to aid a beginner in taking his first cards. 1500 w. Marine Engng—June, 1905. No. 70014 C.

Indicators.

Improved Indicators and Indicator Spring Testing (Indikator, Prüfungs-Einrichtung und Neuerungen an Indikatoren). A description of the spring-testing apparatus of the Dortmund Boiler Inspection Association, with illustrations of new outside-spring indicators. 1500 w. Glückauf—May 20, 1905. No. 70451 D.

Oil Burning.

Oil Burning in Steam Boilers. W. H. Fowler. Compares coal and petroleum as a fuel, discussing the properties of the latter, the method of burning, and related matters. Ills. 2500 w. Mech Engr —May 20, 1905. No. 69940 A.

Piping.

Notes on Steam Pipes (Betrachtungen über Dampfrohrleitungen). E. Kühne. A discussion of the stresses on steam pipes, both internal and external, including the arrangement of flexible and expansion joints. 1500 w. Schiffbau—May 10, 1905. No. 70459 D.

The Trap Return System at the United States Military Academy, West Point, N. Y. Illustrates and describes the method of taking care of the condensation in an extensive system of supply pipe, by the use of Bundy return and tank traps which all feed into a common return main. 1200 w. Power—July, 1905. No. 70394 C.

Separators.

The Separation of Moisture from Steam. R. T. Strohm. Explains why it is desirable to remove the moisture, and discusses methods of accomplishing the separation. Ills. 2300 w. Am Elect'n—June, 1905. No. 70006.

Steam Engines.

The Development of the Steam Engine in Germany (Die Einführung der Dampfmaschine in Deutschland). Conrad Matschoss. A historical review of steam engineering in Germany, with portraits of engineers and illustrations of old engines. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—June 3, 1905. No. 70407 D.

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Steam Ploughs.

A Technical Study of Steam Ploughs (Ueber die Technische Untersuchung von Dampfpflügen). Josef Rezek. An account of practical tests made with a Fowler steam plow in northern Italy, showing the work accomplished for the fuel consumed. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—May 26, 1905. No. 70442 D.

Steam Trap.

Neilson's Steam Trap. Illustrates and describes a design in which the main delivery valve is operated by the energy of the steam. 700 w. Mech Engr—June 17, 1905. No. 70502 A.

Steam Turbine.

A Ten-Thousand Horse-Power Steam Turbine. Franz Koester. Illustration and description of the 10,000 horse-power Brown-Boveri-Parsons steam turbine at the Rhenanian-Westphalian electricity works, Essen, Germany. 1200 w. Power —July, 1905. No. 70392 C.

Steam Turbines in America. A review of the committee reports to the National Electric Light Assn. on the present condition of the steam turbine in the United States. 3500 w. Eng Rec—June 24, 1905. No. 70380.

Test of a 500 K.W. Turbine Generating Set at the Preussen Mine (Untersuchung einer 500 K.W. Turbodynamo für die Zeche Preussen I). F. Schulte. Tests of an A. E. G. turbine dynamo, showing a steam consumption of 23.7 pounds per kilowatt hour. 1200 w. Glückauf—May 20, 1905. No. 70450 D.

The British Thomson-Houston Works at Rugby. Editorial account of a visit to their works at Rugby and description of the Curtis turbine. 3000 w. Engng—May 19, 1905. No. 69947 A.

The De Laval Steam Turbine in America. John L. Mohun. An illustrated article recording the progress which has been made in the use of steam turbines for direct connecting to other machinery than electrical. 1800 w. Cassier's Mag—June, 1905. No. 69967 B.

Superheater.

The Schmidt Superheated Steam Locomotive. Emile Guarini. Illustrated description of an application of highly superheated steam to locomotives. 1000 w. R R Gaz—Vol. XXXVIII. No. 24. No. 70267.

The Use of Superheated Steam on Locomotives. H. H. Vaughan. Read before the Am. Ry. Mas. Mech. Assn. Reviews the history of the use of superheated steam, discussing briefly the theory and results, and giving conclusions. Ills. 10000 w. Ry & Engng Rev —June 17, 1905. No. 70287.

Traction Engines.

Accidents with Traction Engines. William Fletcher. Describes some of the roads these engines have to traverse, and relates accidents that have taken place. Ills. 1400 w. Prac Engr—May 19, 1905. No. 69938 A.

Vacuum.

The Effects of Vacuum on Steam-Engine Economy. R. M. Neilson. An illustrated review of central-condensing systems, cooling towers, and the auxiliary machinery of the condensing plant. Ills. 3600 w. The Engineering Magazine—July. Serial. 2nd part. No. 70485 B.

Valves.

Self-Closing Valves (Selbstschlussventile). R. Pöthe. Illustrating and describing a variety of automatic valves which act to shut off steam in case of explosions or breakages of pipes or mains. Three articles—4500 w. Schiffbau—April 26, May, 10, 24, 1905. No. 70458 each D.

The Drop Valve and Its Gear. An illustrated discussion of the design of drop valve gears, describing some early designs, and the changes. 2200 w. Engr, Lond—May 26, 1905. Serial. 1st part. No. 70123 A.

Valve Setting.

Setting Direct and Indirect Link Motion. H. H. Kelley. An illustrated article giving directions for setting both the direct and indirect link gears. 2300 w. Engr, U S A—June 15, 1905. No. 70281 C.

Water-Tube.

A New Water-Tube Boiler. Illustrated description of the Keeler water-tube boiler and superheater. 1200 w. Engr, U S A—June 1, 1905. No. 69981 C.

Water Softening.

Notes on Softening and Purification of Water for Steam Raising. Louis J. Le Clair. Abstract of a paper read before the Dublin Soc. of the Inst. of Elec. Engrs. Considers the causes of temporary and permanent hardness, and Dr. Clark's method of treating the water for hardness and methods of eliminating oil. 2800 w. Prac Engr—May 19, 1905. No. 69939 A.

MISCELLANY.

Aeronautics.

A Bird as a Model for the Aeroplane. Illustrated report of investigations by three British experimentalists, showing the apparatus used. 2000 w. Sci Am—July 1, 1905. No. 70549.

Lifting Experiments with a Helicopter (Expériences d'Enlevement d'm Hélicoptère). S. A. S. le Prince de Monaco. Describing tests with the Léger machine,

having two propellers revolving in opposite directions on the same vertical axis. 1000 w. Comptes Rendus—May 15, 1905. No. 70432 D.

Recent Experiments with the Leger Helicopter (Nouvelles Expériences d'Enlèvement de l'Hélicoptère M. Leger). M. Léger. Experiments with lifting propellers, showing that a motor of 10 h. p. was capable of lifting 100 kg. in addition to its own weight. 1000 w. Comptes Rendus. —June 5, 1905. No. 70438 D.

Wing-Flight—Some Researches at Cambridge. An illustrated article giving interesting results of experiments. 2000 w. Auto Jour—May 27, 1905. No. 70105 A.

Aeroplane.

The Gillespie Aeroplane. Charles B. Hayward. Illustrates this aeroplane, and gives a brief description. 1700 w. Sci Am—June 24, 1905. No. 70349.

Crane.

Electrically Driven Locomotive Crane (Lokomotivkran mit Elektrischem Antrieb). C. Herrm. Findeisen. With details of hoisting and propelling mechanism, wiring, and control. 1200 w. Zeitschr d Ver Deutscher Ing—June 3, 1905. No. 70409 D.

Elevators.

Fundamental Features of Electric Elevators. E. R. Carichoff. The first of a number of articles which will cover the field of electric elevator service. The various systems will be described, the method of control, and the various safety devices. Ills. 2000 w. Elec Rev, N Y—June 24, 1905. Serial. 1st part. No. 70361.

Filter Presses.

Material Used in the Construction of Filter Presses. Emil Hatschek. A brief description of the materials available and employed in filter press construction. Ills. 900 w. Elec-Chem & Met Ind—June, 1905. No. 70091 C.

Oil Purification.

The Purification of Waste Lubricating Oil. F. H. Davies. Considers the extraction of mechanical impurities by filtration, illustrating methods. 1700 w. Can Elec News—May, 1905. No. 69955.

Tanks.

Cast-Iron Tanks. W. J. Jones. A discussion of tank design and construction, with illustrations. 8000 w. Public Works —April, 1905. No. 69932 F.

MINING AND METALLURGY

COAL AND COKE.

Alaska.

Petroleum and Coal Fields of the Pacific Coast of Alaska. George C. Martin. From the Geol. Surv. Bul. on this subject. An illustrated article giving information of these fields, their development, deposits, etc. 2500 w. Sci Am Sup—June 24, 1905. No. 70351.

Briquettes.

The Manufacture of Briquettes. Translated from *Der Stein der Weisen.* Explains the methods of forming both anthracite and bituminous briquettes, illustrating ovens used. 2000 w. Sci Am Sup —July 1, 1905. No. 70552.

Coal Fields.

The Coal Fields of Arkansas and Indian Territory. Carl Scholz. Brief illustrated description. The coals are bituminous and semi-anthracite. 1200 w. Min Mag—June, 1905. No. 70215 C.

The Concealed Coalfield of Yorkshire, Darbyshire, and Nottinghamshire. From the report by P. F. Kendall. Gives conclusions reached, and map, with a summary of the evidence for the boundaries. 3800 w. Ir & Coal Trds Rev—May 19, 1905 No. 69952 A.

Cumberland Gap.

The Cumberland Gap Coalfield. Notes from a monograph by J. C. Tipton, describing this field. 1300 w. Eng & Min Jour—June 15, 1905. No. 70273.

Electricity.

Electricity in German Collieries. E. O. Forster Brown. From a paper read before the Mining Institute of Scotland, giving a statement of the methods used in German collieries and the extent to which electricity has been adopted. 900 w. Eng & Min Jour—June 8, 1905. No. 70147.

Explosions.

Mine Explosions. J. T. Beard. Explosions due to excessive use of powder and other causes are discussed, and the energy developed in the combustion of powder and coal dust. 3000 w. Mines & Min—June, 1905. Serial. 1st part. No. 70082 C.

The Zeigler Mine Explosion. J. T. Beard gives the report of the Illinois State Mining Board with a brief descrip-

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tion of results of the explosion. 2200 w. Mines & Min—June, 1905. No. 70080 C.

Filling.

The Conveyor-System for Filling at the Coal-Face, as Practiced in Great Britain and America. W. C. Blackett and R. G. Ware. Abstract of a paper before the Inst. of Min. Engrs., with discussion. 4700 w. Ir & Coal Trds Rev—June 9, 1905. No. 70317 A.

Lignite.

The Utilization of Slack in the Bohemian Lignite Mines (Die Verwertung der Kohlenlösche auf den Böhmischen Braun Kohlengruben). Wilhelm Schöndeling. A discussion of methods of briquetting and coking lignite slack and dust, from a commercial point of view. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—May 20, 1905. No. 70447 D.

Peat.

The Use of Low Value Fuels with Especial Reference to Peat (Die Verwertung Minderwertiger Brennstoffe insbesondre des Torfes). Hr. Gercke. A discussion of the various methods of preparing peat as fuel, and the best appliances for burning it. 3000 w. Zeitschr d Ver Deutscher Ing—May 27, 1905. No. 70413 D.

Queensland.

Central District Coal Measures. Walter E. Cameron. A report of field work with the object of tracing the continuation of these coal measures towards the Mackay and Nebo districts. Map. 3000 w. Queens Gov Min Jour—April 15, 1905. Serial. 1st part. No. 69953 B.

Safety Lamps.

New Safety Lamps Authorized for Use in Belgian Mines. V. Watteyne and S. Stassart, in *Annales des Mines de Belgique*. Illustrated description. 800 w. Col Guard—May 26, 1905. No. 70116 A.

Shot-Firing.

Some Suggestions on Shot-firing. Suggestions made by A. L. Hayden to the Kansas Commission on accidents in coal mines. 1200 w. Eng & Min Jour—June 15, 1905. No. 70275.

Underground Fires.

The Occurrence of Underground Fires at the Greta Colliery, New South Wales. J. Jeffries. Abstract of a paper read before the Inst. of Min. Engrs. Gives the writer's opinion of the cause of the fires. 2200 w. Ir & Coal Trds Rev—June 9, 1905. No. 70318 A.

COPPER.

Arizona.

In the Chiricahuas-Cochise County, Arizona. Brief description of the development of properties in Paradise Camp, recently attracting attention for the copper deposits. Ills. 1400 w. Min Rept—June 22, 1905. No. 70375.

Assay.

The Iodimetric Determination of Copper. T. Brown, Jr. A discussion of the methods used. 1400 w. Eng & Min Jour—June 8, 1905. No. 70151.

Concentration.

Concentration of Copper Ore. Frank H. Probert. An illustrated article giving results of experiments at Arizona mines, concerning the economical concentration of low grade copper ore. 2000 w. Eng & Min Jour—June 8, 1905. Serial. 1st part. No. 70149.

Cyanidation.

Ammonia Cyanidation of Copper. Abstracted from the discussion of the paper by Jarman and Brereton. 3300 w. Eng & Min Jour—June 22, 1905. No. 70366.

Utah.

Ore deposits of Bingham, Utah. J. M. Boutwell. An illustrated account of this copper producing camp, its geology, ores, etc. 2200 w. Eng & Min Jour—June 22, 1905. No. 70364.

Ore Deposits of Bingham, Utah. J. M. Boutwell. Descriptive account. 2200 w. Min Wld—June 17, 1905. No. 70284.

Vancouver.

Copper Property at East Sooke, Vancouver Island. Report of this property, its geology, characteristics, developments, &c., by W. M. Brewer. 1700 w. B C Min Rec—May, 1905. No. 69957 B.

GOLD AND SILVER.

Amalgamation.

Amalgamating Gold Ores. Algernon Del Mar. Gives the writer's ideas, based upon western experience. 2000 w. Min & Sci Pr—June 10, 1905. No. 70276.

Assaying.

Correcting an Error in the Fire Assay. Charles Finley Easton. Gives experiments and details of operations in the use of a method explained in detail in an earlier article. 2000 w. Min Rept—June 22, 1905. No. 70377.

China.

The Tien Pan Shan Mines. John C. Shengle. Illustrated description of the Chinese method of working these silver mines. 700 w. Eng & Min Jour—June 1, 1905. No. 70027.

Concentration.

The Jackson Concentrating Works, Idaho Springs, Colorado. C. M. Rath and R. L. Grider. Describes the mill and

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the treatment of the ore. 1500 w. Min Rept—June 1, 1905. No. 70044.

Cyanide.

Cyanidation at Cripple Creek. G. E. Wolcott. Gives information concerning the methods of the Homestake company. 1200 w. Eng & Min Jour—June 8, 1905. No. 70148.

The Cyanide Process. From a treatise from the Redwood Mfrs. Co., San Francisco, Cal., written by Mr. Brown. A description of the cyanide process and some points governing the construction of cyanide plants. 3000 w. Min & Sci Pr—May 27, 1905. Serial. 1st part. No. 69999.

Dredging.

Dredging for Gold in British Columbia. Notes from the annual report of the Minister of Mines. 2800 w. B C Min Rec—June, 1905. No. 70530 B.

The Twentieth-Century Gold Ships and their cargoes. Alex Del Mar. A graphic statement of the progress and possibilities of gold dredging, the general requirements of dredge construction and operation, and the prospective effect on the world's output of gold. Ills. 3000 w. The Eng Mag—July, 1905. No. 70480 B.

Homestake.

Discovery and Development of the Homestake Mines of South Dakota. Historical review, with illustrations of these famous gold mines, and the methods of working them. 4000 w. Min & Sci Pr—June 17, 1905. Serial. 1st part. No. 70353.

Lime.

Notes on Lime, Clean Up, etc. Gerard W. Williams. Gives methods of determining the available caustic lime in a sample, showing that the efficacy of lime for the purposes for which it is employed in cyanide works is more than directly proportional to the percentage of free lime. Also a method of determining the percentage of free acid in the solutions from the acid treatment of zinc. 3500 w. Jour Chem, Met. & Min Soc of S Africa—April, 1905. No. 70303 E.

Mount Lyell.

Mount Lyell Mining Field. Prof. J. W. Gregory. The present number describes the geology and character of this Australian mining district. 2800 w. Aust Min Stand—April 26, 1905. Serial. 1st part. No. 70103 B.

Nevada.

Goldfield District, Nevada. Illustrated description of the geology of this district, as given by J. E. Spurr, in Bul. 260, U. S. Geol. Survey. 2500 w. Min & Sci Pr—June 17, 1905. No. 70354.

Nicaragua.

Mining in Nicaragua. H. E. West. An illustrated account of the mining industry which is confined to gold and silver mining. 2000 w. Min Mag—June, 1905. No. 70213 C.

Placers.

The Origin and Classification of Placers. H. L. Smyth. Aims to show how the distribution and concentration of the valuable particles in placers are dependent on the conditions under which erosion, transportation and deposition takes place. 2000 w. Eng & Min Jour—June 1, 1905. Serial. 1st part. No. 70032.

Queensland.

The Gympie Goldfield. F. Danvers Power. An illustrated description of this field, which is the third largest producer in Queensland, with an account of its discovery. 1800 w. Eng & Min Jour—June 1, 1905. No. 70030.

Refining.

Refining Gold Bullion and Cyanide Precipitates with Oxygen Gas. T. Kirk Rose. Discusses the action of oxygen and of nitrogen, on molten metals, and on mixtures, the treatment, methods, etc. 1500 w. Inst of Min & Met—April 13, 1905. No. 70212 D.

Santo Domingo.

Gold in Santo Domingo. F. Lynwood Garrison. An illustrated article describing this island and reviewing what is known of its geology and gold ores. 2700 w. Eng & Min Jour—June 15, 1905. No. 70272.

Slimes.

The Moore Process. C. H. Fulton. Information concerning the improved Moore slime-filter and the results obtained. 1100 w. Eng & Min Jour—June 1, 1905. No. 70029.

Smelter.

A New Pyrite Smelter. Herbert Haas. Illustrated description of the copper smelter of the Great Western Gold Co., at Ingot, Col. 1200 w. Eng & Min Jour—June 8, 1905. No. 70146.

Sulphides.

The Treatment of Refractory Auriferous Sulphides at the Cassilis Mine, Victoria, Australia. Francis B. Stephens. Read before the Inst. of Min. & Met. Describes the ore and the methods of treatment, giving costs. 4000 w. Min Jour—June 3, 1905. No. 70193 A.

Tonopah.

Geology of Tonopah District, Nevada. Information from the latest report of J. E. Spurr, as given in Bulletin 260 of the U. S. Geological Survey. 3000 w. Min & Sci Pr—June 10, 1905. No. 70277.

Transvaal.

The Gold Bearing Reefs of the Mur-

chison Range Districts, Transvaal. Hans Merensky. A report with special consideration of the ore deposits of the Free State, Blue Jacket, and Lawrence mines. Ills. 3000 w. Min Jour—June 10, 1905. No. 70308 A.

Values.

Table of Assay and Coinage Values for Gold. R. J. Holland. Tables with explanation. 2500 w. Min Mag—June, 1905. No. 70216 C.

Washington.

The St. Helena Mining District. Harvey W. Bailey. Information concerning this district in the Pacific north-west, where gold, silver, lead, iron, copper, zinc and other valuable minerals are found. 2300 w. Ills. Min Wld—June 3, 1905. No. 70034.

IRON AND STEEL.

Blast Furnaces.

The Detroit Iron and Steel Company's Blast Furnace Plant. Illustrated description of these works and their equipment. 1400 w. Ir Age—June 1, 1905. No. 69958.

The Zug Island Furnace of the Detroit Iron and Steel Co. Illustrated detailed description of the blast furnace especially designed for the production of foundry pig iron. 2500 w. Ir Trd Rev—June 1, 1905. No. 69982.

Dry Air Blast.

Dry Air Blast and Turbine Blowing Engines. Abstract translation of an article by Prof. Mathesius, in *Stahl und Eisen*, describing a new method of drying the blast. 2000 w. Ir Age—June 1, 1905. No. 69960.

The Use of Dry Air in Blast Furnaces. Articles by A. Pourcel, and O. Boudouard, translated from *Revue de Metallurgie*. 1800 w. Ir & Steel Mag—June, 1905. No. 70225 D.

Electric Driving.

The Electric Driving of Rolling Mills. Brief illustrated account of two modern German rolling mills equipped electrically. 900 w. Elect'n, Lond—June 16, 1905. No. 70506 A.

Electric Smelting.

The Present Status of Electric Smelting of Iron and Steel (Der Gegenwärtige Stand der Elektrischen Eisen und Stahl Eszengung). Dr. H. Borchers. An examination of the commercial operation of existing processes, holding them all to be yet in the experimental stage. 2000 w. Zeitschr d Ver Deutscher Ing—June 10, 1905. No. 70418 D.

Ferro-Vanadium.

Manufacturing and Metallurgy of Ferro-Vanadium. J. Baxeres de Alzugaray. Information about the properties this alloy imparts to iron and steel, and the progress made by this new industry. 1600 w. Min Wld—June 4, 1905. No. 70371.

Puddling.

The Roe Mechanical Puddling Process. Joseph Hartshorne. Describes this process and the recent improvements introduced. 3800 w. Ir Age—June 15, 1904. No. 70211.

Sulphur.

The Determination of Sulphur in Iron Ores. J. Howard Graham. Work undertaken to test statements made by Williams, and to determine the influence of ammonium chloride, hydrochloric acid, and ferric chloride in solution, on the precipitation of barium sulphate. 3300 w. Jour Fr Inst—June, 1905. No. 70219 D.

Vanadium.

Vanadium and Vanadium Steel. Gives a résumé of the methods by which this metal has been extracted from its ores, and discusses the properties of the vanadium steels. 2500 w. Engr, Lond—June 9, 1905. No. 70309 A.

MINING.

Boring.

Methods and Appliances for Deep Boring (Kurze Uebersicht der Verfahren und Einrichtung zum Tiefbohren). Paul Stein. A general review of deep boring and prospecting practice in Germany, with illustrations of machinery and tools. Two articles. 4500 w. Glückauf—May 20, 27, 1905. No. 70449 each D.

Cage Chains.

German Types of Cage Chains. Illustrates both favorable and unfavorable types, with a discussion of causes of accidents. 900 w. Col Guard—June 16, 1905. No. 70509 A.

Dislocations.

Simultaneous Joints. George F. Becker. Discusses the systems of joints of simultaneous origin, found distributed over rock exposures, etc. 3300 w. Eng & Min Jour—June 22, 1905. No. 70365.

Drill Sharpening.

The "Ajax" Rock-Drill Sharpener. Illustrated description, with a comparison of the cost of hand and machine sharpening. 600 w. Engng—May 19, 1905. No. 69945 A.

Electric Winding.

Electrically-Driven Winding Engines. Remarks on the selection of a system and type of motor, with brief descriptions of some installations erected by the Allgemeine Elektricitäts-Gesellschaft, Berlin. Ills. 4500 w. Elec Engr, Lond—June 2, 1905. No 70189 A.

We supply copies of these articles. See page 797.

Explosions.

See Mining Engineering, Coal and Coke.

Fissure Veins.

Fissure Veins and Ore Deposits as Waterways. Arthur Lakes. An illustrated article explaining some of the evidences that these veins are, or have been, water carriers. 1800 w. Min Wld—June 24, 1905. No. 70370.

Haulage.

A complete Electrical Installation Underground. Brief illustrated description of the electrical plant at the United National Collieries, Rhondda Valley, South Wales. 1700 w. Col Guard—May 26, 1905. No. 70115 A.

Head Frames.

The Rational Design of Head Frames for Mines. George S. Binckley. An illustrated article which the writer offers for consideration. 1200 w. Min & Sci Pr—June 10, 1905. No. 70278.

Hoisting.

Hoisting Rope Connections (Förderkorb-Zwischengeschirre). H. Eigen. An illustrated discussion of the best methods of attaching wire hoisting ropes to cages and buckets. 1500 w. Glückauf—May 27, 1905. No. 70452 D.

The Commercial Selection of Hoisting Ropes (Beitrag zur Wirtschaftlichen Wahl von Förderseilen). Ernst Schmid. An examination of winding ropes for mines with diagrams enabling a selection to be made according to the depth, load and quality. Two articles. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 27, June 3, 1905. No. 70448 each D.

See also Winding.

Mineral Zone.

The International Mineral Zone. Horace F. Evans. Begins a discussion of some of the problems of the region on the boundary between the United States and British Columbia. 1200 w. Min Wld—June 5, 1905. Serial. 1st part. No. 70035.

Mine Surveying.

Henderson's Rapid Traverser. Herbert Perkin. An illustrated description of the instrument and the method of using, discussing the conditions under which its use is of advantage. 1200 w. Mines & Min—June, 1905. No. 70081 C.

Power.

Central Power Stations for Mines. An account of an innovation being introduced in South Africa, with report of cost. 3500 w. Engr, Lond—June 2, 1905. No. 70198 A.

Power for Coal Mining Machinery. G. E. Lynch. Considers the relative efficiencies and advantages of compressed air and electricity, and the machines and uses to which each is adapted. Ills. 4000 w. Mines & Min—June, 1905. No. 70079 C.

Separator.

The Blake-Morscher Electrical Ore Separator. A. M. Plumb. An account of the application of this process to the complex ores of the old Galena district in Illinois and Wisconsin. Ills. 1600 w. Min Mag—June, 1905. No. 70214 C.

See also Electrical Engineering, Electro Chemistry, Concentration.

Sinking-Pump.

Electrically-Driven Turbine Sinking-Pump. Illustrated description of a mine pump of English manufacture. 800 w. Engng—May 26, 1905. No. 70121 A.

Timbering.

Shaft Timbering at the Kennedy Mine. F. J. Girard. Illustrates and describes methods used in the deepest mine in California. 900 w. Min & Sci Pr—May 27, 1905. No. 69998.

Winding.

Electric Winding Engines (Les Machines d'Extraction Electriques). H. Schmerber. With illustrations and details of a number of electrically operated hoisting engines for mines in France and Germany. Two articles, two plates. 6000 w. Génie Civil—May 27, June 3, 1905. No. 70424 each D.

1500-Horse-Power Winding Engine at the Liege Exhibition. Illustrated description of an engine with two horizontal twin cylinders, driving a shaft on which are keyed two winding drums for flat fibre cables. 900 w. Engng—June 16, 1905. No. 70512 A.

See also Hoisting.

MISCELLANY.

Cuba.

Notes on Cuba. W. J. Morgan. An illustrated article giving information of roads and railroads, climate, soil, etc. 1800 w. Ry & Loc Engng—June, 1905 No. 70092 C.

Kaolin.

Kaolin, or China Clay. J. H. Collins. Describes the deposits and methods of working. 2000 w. Eng & Min Jour—June 8, 1905. No. 70145.

Mexico.

Thirty Days of a Mining Engineer's Life in Mexico. E. A. H. Tays. An interesting account of difficult traveling in the mining districts. Ills. 4000 w. Min & Sci Pr—June 3, 1905. Serial. 1st part. No. 70175.

Oil Fields.

The Muscogee Oil Fields. H. B. Conner. An account of a recent discovery in

Indian Territory. 1400 w. Min Wld—June 17, 1905. No. 70283.

Peru.

Peru. Russell T. Mason. A sketch of the mining progress and conditions. The ores are principally copper, silver, lead and coal is also found. 3000 w. Eng & Min Jour—June 8, 1905. No. 70150.

Philippines.

The Mineral Resources of the Philippines. Nearly full report of Capt. H. D. McCaskey, concerning the mineral resources of the islands, giving a summary of information available to date. 3500 w. Eng & Min Jour—June 1, 1905. No. 70031.

Quicksilver.

Chinese Methods of Mining Quicksilver. Henry Brelich. Describes the methods in the Wan Shen Chang mines, showing how they make a living by mining low grade ore in the most antiquated way, and smelting it with the most primitive appliances. Ills. 2500 w. Min Jour—May 27, 1905. Serial. 1st part. No. 70113 A.

Rubies.

The Artificial Production of Rubies. Translated from *La Nature*. Describes the production of rubies by fusion. Ills. 1200 w. Sci Am Sup—June 3, 1905. No. 69995.

Semi-Precious Stones.

The Semi-Precious Stones of the United States. E. A. Reed. Information concerning agates moss agates, agatized wood, tourmaline, amazon stone, bloodstone, chrysoprase, and others. 3500 w. Min & Sci Pr—June 3, 1905. No. 70176.

Tin.

The Search for Tin. Gives a summary of places in the United States where tin ore is known to have been found, with a brief description of the mode of occurrence and means for determining the mineral. 1500 w. Min Rept—June 22, 1905. No. 70376.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

High Speeds.

High-Speed Railway Trains in Germany (Essais de Trains à Marche Rapide en Allemagne). Describing trials of steam locomotives on the Marienfelde-Zossen military railway, showing that speeds of 120 kilometres per hour were readily attained. 1800 w. Génie Civil—June 3, 1905. No. 70427 D.

Train Operation.

Points to be Observed by Enginemen While in Service in Order to Successfully Meet Modern Methods of Freight and Passenger Train Operation. W. J. Hurley. Reviews the methods of successful engineers. Discussion. 8500 w. Pro Cent Ry Club—May, 1905. No. 70322 C.

MOTIVE POWER AND EQUIPMENT.

Accounting.

Rational Locomotive Repair Records. H. H. Vaughan. Discusses the various factors entering into the maintenance of locomotives account, and explains method giving statement showing the cost of running repairs. 5500 w. Am Engr & R R Jour—June, 1905. No. 70019 C.

Brakes.

Maximum Brake Force as Regards Foundation Brake for Passenger and Freight Cars. F. M. Nellis. Read before the Air Brake Assn., at New Orleans. Discusses the new system of unbraked weight per car axle. 2200 w. Ry & Engng Rev—June 10, 1905. No. 70180.

Cars.

Combination, Box and Tank Car. Brief illustrated description. 500 w. R R Gaz—Vol. XXXVIII. No. 24. No. 70263.

Framing of Passenger and Freight Cars. C. A. Seley. From an address before the students of Purdue Univ. Reviews the development and present practice in Europe and America. 4800 w. Ry & Engng Rev—June 10, 1905. No. 70178.

New York Central Steel Underframe Gondola Car. Illustrates and describes new cars which show original features of design. 600 w. Ry Age—June 23, 1905. No. 70360.

Counterbalancing.

Balancing Balanced Compound Locomotives. Gives method of counterbalancing revolving parts on a crank-axle. Ills. 500 w. Am Engr & R R Jour—June, 1905. No. 70024 C.

Counterbalance for Balanced Compound Locomotives. Lawford H. Fry. Illustrations showing the position of the counterbalance, with explanation of the reason. 600 w. R R Gaz—Vol. XXXVIII., No. 23. No. 70163.

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Draft Gear.

Friction Draft Gear. R. H. Blackall. Discusses the special advantages, uses and cost, and gives comparative results of twin and friction gears in service. 3000 w. R R Gaz—Vol. XXXVIII., No. 24. No. 70260.

Relative Efficiency Tests of Friction and Spring Draft Gear. Illustrated description of testing machine and tests made at the Appliance Exhibition in Washington. 600 w. R R Gaz—Vol. XXXVIII., No. 23. No. 70161.

Dynamometer.

Dynamometer Car. Drawings and description of a new car on the New York Central lines. 600 w. Am Engr & R R Jour—June, 1905. No. 70020 C.

Electric Locomotive.

See Street and Electric Railways.

Electric Traction.

See Street and Electric Railways.

Freight Cars.

Standard Freight Cars on the Pennsylvania Railroad. Illustrates and describes the various types. 2500 w. Ry & Engng Rev—June 17, 1905. No. 70286.

Locomotive Performance.

Locomotive Performance Under a Steam Pressure of 250 Pounds. W. F. M. Goss. An account of an investigation conducted under the patronage of the Carnegie Institution. 1800 w. R R Gaz —Vol. XXXVIII., No. 23. No. 70167.

Performance of Mallet Compound Locomotive. Report of J. E. Muhlfeld, general superintendent of motive power of the B. & O., giving information in regard to the performance of the articulated duplex compound locomotive, No. 2400, which was exhibited at St. Louis. 1200 w. Am Engr & R R Jour—June, 1905. No. 70023 C.

Performance of the Baltimore and Ohio Ry.'s Mallet Compound Locomotive in Service. Illustration, with report of the working, coal consumption, road record, &c. 1200 w. Eng News—June 15, 1905. No. 70240.

Locomotives.

A French Locomotive with Water-Tube Boiler. Describes a locomotive, designed by Jacques Robert, for the Algerian division of the Paris, Lyons & Mediterranean Ry. Ills. 500 w. Eng News—June 15, 1905. No. 70239.

A New Design for a Four-Cylinder Balanced Compound Locomotive. Samuel F. Prince. A description of the writer's four-cylinder balanced system. Ills. 700 w. R R Gaz—Vol. XXXVIII., No. 23. No. 70162.

An Old High-Speed Locomotive. Herbert T. Walker. Historical sketch and illustrated description of the "Cornwall," first built in 1847. and rebuilt in 1858. It is running to-day. 1700 w. Sci Am—June 10, 1905. No. 70170.

Common Standard Locomotives. Illustrates and describes details of the standard locomotives for the Harriman lines. 1000 w. Am Engr & R R Jour—June, 1905. No. 70021 C.

Compound Freighter for the Central Vermont. Illustration, description, and principal dimensions. 500 w. Ry & Loc Engng—June, 1905. No. 70093 C.

Express Locomotive for the Cambrian Railways. Illustrates and describes some fast and powerful four-coupled leading bogie locomotives for conveying mails and tourist traffic. 400 w. Engng—May 26, 1905. No. 70120 A.

Four Cylinder Compound Locomotive, G. N. R. Illustrates and describes one of a new series of Atlantic type locomotives recently put into service on the Great Northern Ry. 500 w. Engr, Lond —May 19, 1905. No. 69951 A.

Heavy Passenger Locomotives for the C. M. & St. P. Detail drawings and description of some heavy Pacific type passenger locomotives recently placed in service. 500 w. R R Gaz—Vol. XXXVIII., No. 23. No. 70168.

New York Central Simple Consolidation Engine. Illustration, with description, of an engine on exhibition at Washington, during the International Railway Congress. It has the Walschaert valve gear. 700 w. Ry Mas Mech—June, 1905. No. 70159.

Pacific Type Engine with Superheater, Erie Railroad. Illustrated description of an engine designed to meet hard conditions of service. 700 w. Ry Mas Mech —June, 1905. No. 70158.

Standard Locomotives of the Pennsylvania Railroad. Examines the standard locomotive equipment of this road in the passenger, freight, and switching service. Ills. 2000 w. Ry & Engng Rev—June 10, 1905. No. 70179.

Tests of a Heavy Shay Locomotive. Illustration of a locomotive of the Shay type recently put in service on the Chesapeake & Ohio, with a description of its work as a hill-climber. 500 w. R R Gaz —Vol. XXXVIII., No. 23. No. 70166.

The Development of the Mountain Locomotive (Die Entwicklung der Gebirgslokomotive). Dr. Rudolf Sanzin. An illustrated review of the successive improvements in steam locomotives for use on heavy grades, with especial reference to adhesion engines of Continental design. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—May 19, 1905. No. 70441 D.

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The New Jungfrau Locomotive. Emile Guarini. Illustrates an old and a new Jungfrau locomotive, describing the latter in detail. 1400 w. Sci Am Sup—June 10, 1905. No. 70171.

Oscillations.

The Oscillations of Locomotives under the Perturbing Action of Various Forces (Oscillations des Locomotives sons l'Action de Diverses Forces Perturbatrices). Georges Marié. A study of the influence of inertia and centrifugal forces upon the oscillations of locomotives. 1200 w. Comptes Rendus—May 29, 1905. No. 70434 D.

Postal Car.

Steel Underframe Postal Car for the Santa Fe. Drawings and description. 700 w. R R Gaz—Vol. XXXVIII., No. 24. No. 70261.

Repairs.

Manufacture of Material at a Repair Point. W. F. Jones. Discusses the question from the point of economy and the retaining of men in the dull season. General discussion. 2500 w. Pro Cent Ry Club—May, 1905. No. 70323 C.

Rolling Stock.

South-Eastern and Chatham Railway New Rolling Stock. Illustrates and describes some new first-class passenger saloons and coaches. 900 w. Engr, Lond —May 26, 1905. No. 70125 A.

Shop Practice.

A Large Locomotive-Building and Repair Works in France. C. R. King. An illustrated account of the Epernay Shops of the Est Railway, especially of the general machine-tool equipment and methods. Ills. 3500 w. The Engineering Magazine —July, 1905. Serial. 1st part. No. 70481 B.

Stoker.

The Victor Stoker. Illustrated detailed description of this locomotive stoker, with report of a trip on an engine fitted with it. 3500 w. R R Gaz—Vol. XXXVIII., No. 23. No. 70165.

Superheating.

Superheating Locomotives. Rudolf Vogdt in *Die Umschau*. States briefly the advantages of superheated steam, giving illustrations of several types of locomotive superheaters, and information concerning their use. 1000 w. Sci Am Sup—June 10, 1905. No. 70174.

Test of a Superheater Locomotive. Gives interesting results of a test on the Chicago & Northwestern with superheater locomotives to determine their relative efficiency. 800 w. R R Gaz—Vol. XXXVIII., No. 23. No. 70160.

See also Mechanical Engineering, Steam Engineering.

Valve Gear.

Walschaert vs. Stephenson Valve Gear. A comparison showing the saving in weight by using the Walschaert gear, and giving other facts. Also editorial. 1700 w. Am Engr & R R Jour—June, 1905. No. 70022 C.

NEW PROJECTS.

Mexico.

Mexican Railroads for Mine Development. George E. Walsh. An interesting article showing the intimate connection between the railroads and the mining industries, which are being rapidly developed. 2400 w. Ry Age—June 23, 1905. No. 70359.

New Line.

The San Pedro, Los Angeles & Salt Lake Ry. Reviews the history of the undertaking, recently completed, and gives information concerning the road. Map and cross-sections are given. 1500 w. Eng News—June 22, 1905. No. 70347.

PERMANENT WAY AND BUILDINGS.

Coaling.

Holmen Coaling Station, Pennsylvania Lines. Illustrated detailed description of a type of coaling station being installed at many places on the lines west of Pittsburg. 700 w. Ry Age—June 9, 1905. No. 70129.

Coaling Plant.

The Locomotive Coaling Plant at the Grunewald Station in Berlin (Anlage zur Lokomotivbekohlung auf Bahnhof Grunewald in Berlin). M. Buhle. Illustrated description of a coal pocket and handling plant for railway service. 1000 w. Zeitschr d Ver Deutscher Ing—May 13, 1905. No. 70402 D.

Curves.

The Oscillation of Cars upon Entering and Leaving Curves (Oscillations des Véhicules de Chemin de Fer à l'Entrée en Courbe et à la Sortie). Georges Marié. Deriving equations for computing the oscillations of cars, with suggestions for the improvement of curves and way. 1200 w. Comptes Rendus—May 8, 1905. No. 70430 D.

New Orleans.

The New Orleans Terminal Company. An illustrated detailed description of improvements in the terminal facilities of the New Orleans & Northeastern R. R. 2000 w. Ry Age—June 23, 1905. No. 70358.

Reinforced Concrete.

Reinforced Concrete Structures for Railroads. A. O. Cunningham. States the advantages of this material, discussing some of its applications, especially to bridge construction, and particulars in regard to the systems, with stresses, &c. 4000 w. Ills. Trans Assn of Civ Engrs of Cornell Univ—1905. No. 70545 F.

We supply copies of these articles. See page 797.

Resistance.

Train Resistance in Relation to the Track. P. H. Dudley. Reviews the reduction in train resistance and the factors that have most contributed to improvement, studying the effect of the distribution of loads, and the condition of tracks. 4500 w. Harvard Engng Jour—June, 1905. No. 70208 D.

Shops.

Fire Protection in Railroad Shops. H. S. Knowlton. Suggestions concerning means that should be taken to guard against fire. 1800 w. Ry Age—June 9, 1905. No. 70128.

Side-Leveler.

A Contractor's Side-Leveler. George W. Lee. Illustrates and describes a very useful mcahine in roadbed construction, which can be quickly built at moderate cost. 800 w. Eng News—June 15, 1905. No. 70236.

Signaling.

Electrical Features of Block Signaling. L. H. Thullen. Gives a brief sketch of the older methods of signaling, and an illustrated description of the modern electric signals. 2400 w. Am Inst of Elec Engrs—June, 1905. No. 70248 D.

Track.

What Will Be the Future Railway Track for Heavy Traffic? Editorial discussion of this subject, quoting from an editorial in the *R. R. Gazette*. 2800 w. Eng News—June 8, 1905. No. 70101.

Train Shed.

The Platform Shelters of the New Lackawanna Terminal at Hoboken. Brief illustrated description of the proposed shed, which consists of a number of low, short-span, longitudinal sections, with the steel protected by concrete. 1000 w. Eng Rec—June 24, 1905. No. 70381.

Yards.

Arrangement and Operation of American Freight Yards. George L. Fowler. Illustrated description of the West Albany yard of the New York Central, and the method of operation. 4200 w. R R Gaz—Vol. XXXVIII., No. 22, No. 69989.

TRAFFIC.

Clearing System.

A Glance at the Railway Clearing House of England—Can the Plan Be Profitably Followed in America? J. W. Midgley. An explanation of the system and of the conditions in England. 3500 w. Ry Age—June 16, 1905. No. 70280.

Rates.

Both Sides of the Rate Regulation Discussion Restated. Gilson Gardner. A statement of the arguments presented in the joint debate carried on in Washington. 3300 w. Ry Age—June 16, 1905. No. 70279.

MISCELLANY.

Inter-Oceanic.

Jubilee of the First Inter-Oceanic Railway. An interesting review of the building of the Panama Railway, completed in 1855. 2000 w. Engr, Lond—June 9, 1905. No. 70313 A.

STREET AND ELECTRIC RAILWAYS

Berlin-Zossen Tests.

The Berlin-Zossen Tests and Their Results. Abstract of an address by Charles A. Mudge, at a meeting of the N. Y. Elec. Soc. Describes the apparatus installed in the Allgemeine car, giving report of tests, and other information of interest. Ills. 3500 w. St Ry Jour—June 3, 1905. No. 70051 C.

Calcutta.

The Calcutta Tramways System. An illustrated detailed description of the electric traction system, with an account of the conditions under which it operates. 5500 w. St Ry Jour—June 3, 1905. No. 70046 C.

The Calcutta Tramways System. Illustrated description of electrification of the tramways system, and a statement of the climatic conditions which cause difficulty in operation. 4000 w. Elect'n, Lond—June 9, 1905. No. 70307 A.

Chicago Subway.

Building the Chicago Subway. William Hard, in *Public Opinion*. An account of the carrying out of this project; with a brief comparison with the methods of the New York subway. 3000 w. R R Gaz—Vol. XXXVIII., No. 22. No. 69988.

Conduit Line.

A Novel Conduit Line. Brief illustrated description of the new electric conduit line of Bastille-Charenton. 1500 w. Sci Am Sup—June 3, 1905. No. 69996.

Consolidation.

Saginaw & Bay City Railway & Light Co. An illustrated article describing a consolidation of four properties in Michigan, to be operated under one management. 3500 w. St Ry Rev—June 15, 1905. No. 70288 C.

Electric Locomotive.

The New Electric Locomotive for the

We supply copies of these articles. See page 797.

Valtellina Road. Illustrated detailed description of this new locomotive. The design of the motor and the method of control are of special interest. Also editorial. 4000 w. Elec Rev, N. Y.—June 24, 1905. No. 70362.

Weight Distribution on Electric Locomotives as Affected by Motor Suspension and Draw-Bar Pull. S. T. Dodd. The discussion is limited particularly to locomotives drawing trailing loads. Ills. 3500 w. Am Inst of Elec Engrs—June, 1905. No. 70250 D.

Westinghouse Single-Phase Electric Locomotive. Illustration and description of an electric locomotive weighing 135 tons for heavy electric traction. 800 w. R R Gaz—Vol. XXXVIII., No. 22. No. 69990.

Electric Traction.

Electric Traction on Railways. Discusses the main points which are essential for success of electric traction on railways, and reviews briefly the various alternating-current motors which have been tried on a large scale. 6000 w. Engng—May 26, 1905. No. 70118 A.

Light Electric Railways. James R. Cravath. From a paper before the Chicago Branch of the Am. Inst. of Elec. Engrs. Sets forth the demand for railways which can be built and operated cheaply for farming districts and small villages. Plans the type of road that will thrive, advocating narrow gage. Also editorial criticism. 2500 w. Eng News—June 29, 1905. No. 70537.

Electrification.

The Electrification of the Metropolitan District Railway. The present article gives principally an illustrated description of the rolling-stock and of the signaling system. 3000 w. Elec Rev, Lond—June 2, 1905. Serial. 1st part. No. 70191 A.

Elevated Construction.

Elevated Construction in Paris and Berlin. John P. Fox. An illustrated article discussing the ballasted construction adopted on the Berlin Stadtbahn, and the ballasted floor of the Paris Metropolitan Railway, and other possible improvements on elevated lines. 1500 w. St Ry Jour—June 24, 1905. No. 70372 C.

Grades.

The Computation of the Maximum Effective Incline for an Electric Railway (Rechnerische Bestimmung der Günstigen Maximalen Steigung für Elektrische Bahnen). Henri Somach. Deriving formulas and curves based upon the adhesion, tractive power, length of road, speed, and other operative conditions. 2000 w. Elektrotech Zeitschr—May 18, 1905. No. 70466 B.

Heavy Traction.

Heavy Traction Problems in Electrical Engineering. Carl L. de Muralt. Considers only problems relating to traction on through lines. 9000 w. Am Inst of Elec Engrs—June, 1905. No. 70254 D.

Interurban.

Electric Railway Developments. Prof. Horace T. Eddy. A general review of developments, especially of interurban lines, and the displacement of steam equipment. 2500 w. Sci Am—July 8, 1905. No. 70618.

London Tubes.

Baker Street and Waterloo Railway. Illustrated detailed description of the construction and equipment of this London tube line. 8000 w. Tram & Ry Wld—June 8, 1905. No. 70396 B.

Motorman's School.

A Motorman's School System in Brooklyn. An illustrated article explaining an interesting system for instructing new motormen for service on surface lines. 3500 w. St Ry Jour—June 17, 1905. No. 70270 C.

Nürnberg.

The Three-Wire Feeder System of the Electric Railway between Nürnberg and Fürth (Die Stromversorgung der Nürnberg Fürther Strassenbahn nach dem Dreileitersystem). Ph. Scholtes. With plan of the line and diagrams showing the change from the two-wire to the three-wire system. 2000 w. Elektrotech Zeitschr—May 25, 1905. No. 70467 B.

Overhead Lines.

On the Use of Aluminium for Overhead Power Lines. W. B. Esson. Gives facts in proof of the opinion that aluminium conductors are not, generally speaking, superior to copper conductors. 2000 w. Elect'n, Lond—June 2, 1905. No. 70187 A.

Ownership.

Contrasts Between Company and Municipal Ownership and Management of Public Utilities. H. W. Blake. Read before the Gt. Ry. Assn. of the State of N. Y. Discusses the general plans for maintaining public utilities, especially as practised in America, favoring private companies rather than municipal ownership. 4500 w. St Ry Jour—July, 1905. No. 70576 C.

Petaluma.

The Petaluma and Santa Rosa Railway. An illustrated description of a road built primarily for the handling of all kinds of express and freight, but also developed for passenger business. 1600 w. St Ry Jour—July 1, 1905. No. 70574 C.

Physical Tests.

Uniform Standards of Examination of Railway Employees. Dr. F. H. Peck.

We supply copies of these articles. See page 797.

Read before the St Ry Assn of the State of N. Y. Deals with the medical tests made of vision, hearing, physical, health, etc. 1600 w. St Ry Jour—Joly 1, 1905. No. 70578 C.

Point Shifter.

A New Automatic Point Shifter. J. P. Tierney. Read before the Dublin Sec. of the Inst. of Elec. Engrs. Illustrated description of the point shifter used on the Dublin United Tramways system. 2500 w. Elec Engr, Lond—June 2, 1905. No. 70190 A.

Power.

Power Generating and Distributing System of the Old Colony Street Railway. Illustrated detailed description of the Quincy Point power house and its equipment, and the power scheme of an extensive system. 3000 w. St Ry Jour—June 10, 1905. No. 70139 C.

Publicity.

Publicity. J. Harvey White. Read before the St. Ry. Assn. of the State of N. Y. Discusses the attitude of the press toward public service corporations, and describes the work of the press agent of the Boston Elevated Company. 2300 w. St Ry Jour—July 1, 1905. No. 70577 C.

Repairs.

Repairs to Equipment. M. M. Nash. Read before the Indiana Elec. Ry. Assn. Suggestions for securing the best results in the maintenance of the equipment. 3300 w. St Ry Rev—June 15, 1905. No. 70289 C.

Shops.

Improvements in Metropolitan Elevated Shops, Chicago. An illustrated article giving information concerning the improvements introduced. 2000 w. St Ry Jour—July 1, 1905. No. 70573 C.

Single Phase.

The Single-Phase Railway System in Italy. E. A. Kerbaker. Describes the Roma-Civita Castellana line now under construction. 2000 w. Elec Rev, Lond—June 2, 1905. No. 70192 A.

Subway Drainage.

Drainage of the Interborough Subway Under the Harlem River. Brief illustrated description of the drainage and pumping system adopted, and the precautions taken to meet possible conditions. 700 w. Ir Trd Rev—June 22, 1905. No. 70355.

Subway Ventilation.

New York Subway Ventilation. Konrad Meier. A discussion of the present condition, showing that the exchange of air is too slow, and the ventilation inadequate. 2000 w. Eng Rec—June 17, 1905. No. 70292.

The Cause of High Temperatures in the New York Subway. Editorial discussion of the amount of heat developed. 1500 w. Eng News—June 15, 1905. No. 70238.

The Problem of Ventilating the New York Subway and Similar Tunnels. Editorial discussion of the heat losses by conduction through the walls of the subway, and remarks on ventilation. 2500 w. Eng News—June 22, 1905. No. 70348.

Three-Phase.

Three-Phase Traction. F. N. Waterman. Deals particularly with specific features of three-phase traction, and with some of the results attained and to be expected in practice. 10300 w. Am Inst of Elec Engrs—June, 1905. No. 70251 D.

Toronto.

Niagara Power at Toronto. Facts as to the railway and lighting situation, which are to receive power from Niagara, 75 miles distant. 2500 w. Elec Wld & Engr—June 24, 1905. No. 70386.

Trolley.

Design of a Pantagraph Trolley. C. P. Nachod. Illustrates and describes the design and gives an investigation of the mechanism. 800 w. Elec Wld & Engr—June 10, 1905. No. 70157.

Valtellina.

Investigations of the Performance of Polyphase Traction on the Valtellina Railway (Versuchsergebnisse über Stromverbrauch und Rückgewinn auf der Valtellinabahn und einige Eigenheiten der Drehstromtraktion). Eugen Cserháti. A detailed examination of the efficiency of polyphase traction with the new locomotives on the Valtellina railway. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—June 9, 1905. No. 70446 D.

The Valtellina Railway. E. Cserháti. A summary of experience and results of tests of the working efficiency and other important features of three-phase railway working. 3500 w. Tram & Ry Wld—June 8, 1905. No. 70397 B.

Wheels.

The Steel Wheel for Street Railway service. George L. Fowler. States the probable advantages of using a steel wheel. and briefly discusses type, material, &c. 2400 w. St Ry Jour—June 17, 1905. No. 70271 C.

We supply copies of these articles. See page 797.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for $2.00, thirty-three for $5, and one hundred for $15.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Air Power. *qr.* New York.
American Architect. *w.* New York.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architecaural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.

Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Page's Weekly. *w.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-w.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Automobiles.

The Automobile Pocketbook. A Compendium of the Gasoline Automobile. By E. W. Roberts. Size 3½ in. by 5 in.; pp. viii, 329. Price, $1.50. Cincinnati: The Gas Engine Publishing Co.

The author of this convenient little handbook is well known as a specialist upon the subject of internal-combustion engines, and he has brought his experience to a most practical service in the preparation of the present volume. After a brief description of the working of four-cycle and two-cycle motors, the author passes at once to the discussion of gasoline as a fuel, including carburetting and ignition, followed by chapters devoted to description of mechanical details and the operation of the different parts essential to all gasoline automobiles. Among the most practical portions we may call attention to the chapters on automobile tests, operation, and care of an automobile, and the method of meeting the various emergencies which are apt to occur on the road. The book is in most convenient form for the pocket, and will doubtless find very general acceptance as the companion of the automobilist everywhere.

Electricity.

Cyclopedia of Applied Electricity. A Practical Guide for Electricians, Engineers, Students, Telegraph and Telephone Operators, and all Others Interested in Electricity. Prepared by a Corps of Experts, Electrical Engineers, and Designers. Five Volumes; Size 7 in. by 10 in. Price per volume, $3.75. Chicago: American School of Correspondence at Armour School of Technology.

The development of correspondence methods of instruction has been accompanied by the production of a number of text books especially adapted for the needs of students in the different courses, and also of much value to many others who may be following independent methods of work. Among these text books we find the excellent electrical series issued by the American School of Correspondence, this forming a department of the Armour School of Technology at Chicago, conducted under the full control of that well-known technical institution.

This series, consisting of five fully illustrated volumes of about four hundred pages each, begins with the elementary principles of electricity, and conducts the student or reader through the practical working methods of electrical measurement to the various details of telegraphy, telephony, electric generators, both continuous and alternating, electric lighting, power, and traction, and the general construction and operation of electric generating stations.

Such a wide field necessarily demands the services of a number of authors, each a specialist in his own line, in order that the whole may be effectively covered, and that such a course has been followed in the preparation of these volumes is evident from a perusal of the list of collaborators. Thus, under the general editorial supervision of Mr. Alfred E. Zapf, the secretary of the American School of Correspondence, we find, as collaborators and authors the names of such specialists as Dr. F. B. Crocker, Professor William Esty, Professor Dugald C. Jackson, Professor George C. Shaad, and a number of others.

The several sections of the books form the instruction papers of the correspondence school, and are accompanied by selected review questions, enabling the independent reader of student to check his own work, while the student in the correspondence school has also the supervising aid and instruction of the school to supplement the books.

For the purpose for which these books are intended it is very necessary that the explanations and descriptions shall be given in the clearest possible manner, and hence the question of the extent to which mathematical methods are to be used becomes important. There are some portions of electrical science which demand the employment of mathematical terms and expressions, but these portions can be made clear to the general reader by the use of carefully written explanations, together with the use of diagrams, and both of these methods have been judiciously employed in the sections requiring them.

Gas Engines.

Gas Engine Design. By Charles Edward Lucke. Size 6 in. by 9 in.; pp. viii, 254. Price, $3.00. New York: D. Van Nostrand Company.

The increasing number of books upon the subject of internal-combustion motors is clearly indicative of the growing interest in this important department of mechanical engineering. Many of the existing works are devoted to what Dr. Lucke calls the qualitative or inventive side of design, and hence he has distinctly limited himself to the quantitative side of design, his book treating solely of the forces in, and the energy-transforming power of, the standard mechanism of the explosion gas engine. The book is the outgrowth of the author's lectures before classes at Columbia University, and in view of the important original investigations which he has conducted in the mechanical laboratory there, and the practical experience thus developed appears in the character of the work.

The first portion of the book treats of power, efficiency, and economy, giving the material necessary for determining the proper piston displacement for a specified output for a given kind of gas. The second part contains the data and method for determining the stresses in the parts, and the arrangement for the production of the required turning moment and proper balance. The third, and larger part of the work covers the computation of the dimensions of the various parts to resist the stresses, including both theoretical analysis and empirical formulas, the discussion extending from the small, high-speed automobile motor to the 5,000 horse power station engine.

It will thus be seen that Dr. Lucke has given the designing engineer a handbook not unlike certain well-known works treating of steam engine design, and its appearance is to be welcomed, not only on account of the intrinsic excellence of the work itself, but also because it indicates the welcome fact that gas-engine design has taken its place as a recognized department of mechanical engineering both in theory and practice.

Mechanics.

Elements of Mechanics. Forty Lessons for Beginners in Engineering. By Mansfield Merriman. Size 5 in. by 7½ in., pp. 172. Price, $1.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

It is a matter for congratulation that the preparation of elementary text books is no longer regarded as beneath the dignity of the eminent engineer or professor, and that books like the above are appearing to enable the beginner to establish a groundwork in accordance with modern methods, a foundation which he shall not have to unlearn as he makes further progress.

Professor Merriman has given in this little work a sufficient presentation of the methods of rational mechanics to enable any student, possessing only a knowledge of plane geometry, elementary algebra, and plane trigonometry, to acquire the fundamental elements of mechanics, and to be ready to advance safely and surely to a higher treatment of the subject when it shall be required. If, as the author says, these forty lessons are thoroughly mastered, a solid substructure will be formed upon which applied mechanics may safely stand, and this is all that many will need, while those who desire to proceed further will be far better equipped if they have taken this course than if they have had a less substantial groundwork.

Piping.

Steam Pipes. Their Design and Construction. By William H. Booth. Size 6 in. by 9 in.; pp. x, 187. Price, 6s., $2.00. London: Archibald Constable & Co., Ltd. New York: The Norman W. Henley Publishing Company.

Mr. Booth has here taken up a subject concerning which there is elsewhere little modern information to be found, and has given it a very systematic and scientific consideration. The older formulas were empirical in their nature and were based upon conditions long since obsolete, so that it was necessary to take up the subject anew and treat it wholly upon its merits, conforming to existing practice and commercial conditions only so far as absolutely necessary.

After discussing the relation of the flow of steam to the dimensions of the conveying pipe, Mr. Booth proceeds to examine the materials employed for different uses, taking into account especially the demands of modern high pressures and superheating temperatures. Especially important are the methods of providing for expansion and contraction strains, together with the stresses which are liable to be caused by improper methods of making connections and defective drainage, these frequently being greater in magnitude and effect than those due to the internal pressure. Questions of general arrangement and erection of pipe systems are discussed, together with details of valves, fittings and flanges, there being also a chapter upon separators, and one upon superheated steam. The book concludes with an examination of the kinetic theory of gases in relation to the flow of steam. Although based mainly upon British practice, the book is of distinct value to engineers in all parts of the world, and it will doubtless fill a place in engineering literature hitherto vacant.